DISEASES OF THE URINE.

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AN

INQUIRY

INTO THE

NATURE AND TREATMENT

OF

GRAVEL, CALCULUS,

AND

OTHER DISEASES

CONNECTED WITH

A DERANGED OPERATION

OF THE

URINARY ORGANS.

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PREFACE.

THE author of the present volume has been in the habit for many years of closely attending to the Diseases of the Urine; and the following pages exhibit an outline of his observations on the subject. With his own observations, the principal facts and opinions of others have been likewise incorporated; while, on the other hand, to avoid controversy, whatever appeared doubtful has been in general omitted without remark.

It was his original intention to prefix an historical introduction respecting the urine, with a detailed account of the chemical experiments on which many of his peculiar views are founded; but upon reflection, he was induced to relinquish both these objects for the present, and to confine his attention chiefly to practical points. Chemical details could not, indeed, be altogether avoided, because chemistry constitutes the very basis on which the whole superstructure is founded; care, however, has been taken to render them as plain and concise as possible, and thus to present such a view of this part of the inquiry as may be intelligible to the general reader.

To *establish* new views on medical subjects is almost too much for an individual to hope. The author there-

fore, has chiefly confined himself to *illustration;* and, leaving it to the profession at large to *establish* his conclusions (if they are capable of being established), rests in the mean time perfectly satisfied that justice will be done to his attempts.

The author's steady aim throughout his researches has been to arrive at *truth;* and whoever will direct him to this object, where he has failed to reach it, will be esteemed a friend. He never aspired to perfection; but if he has succeeded in throwing some light on the pathology of these important diseases—if he has furnished a clue by which their pathology may be still further extended—if he even convinces a single individual, that it is impossible to know any thing about the diseases of the urine, without repeated and careful examination of that secretion, he will not deem his labours altogether useless.

Southampton-street, Bloomsbury-square,
12th December, 1820.

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ERRATA.

Page 12 line 16 *for* pure, *read* free.
13 — 11 ditto.
— — 16 ditto.
15 — 3 ditto.
27 — 16 *for* renewed, *read* removed.
151, in the title of the chapter, *for* earthy, *read* alkaline.

INTRODUCTION,

Presenting a contrasted View of the Elementary Principles of the Human Urine and Blood.

IN order to exhibit the peculiarities of the urine, and the morbid conditions to which it is liable, in a more striking point of view, I purpose, in the following sketch, to consider the various principles which enter into its composition, with reference to those entering into the composition of the blood from which it is formed. Hence it will be necessary to premise a summary description of these two fluids.

Blood is that well-known red fluid existing in certain vessels (hence denominated blood-vessels), from which all animal products are formed. Its consistence is somewhat thick, and it has a saponaceous feel. Its taste is slightly saline, and its odour peculiar, and more or less strong in different animals. Its specific gravity varies in the same animal at different times; but, generally speaking, the specific gravity of human blood may be said to be between 1·030 and 1·050. Though blood, as it circulates

through the body, seems to be a homogeneous fluid, it appears under the microscope to be heterogeneous, and presents the appearance of *solid red particles*, of a globular figure, diffused through a colourless liquid. Blood, when removed from the body, in a very short time spontaneously undergoes a remarkable change, termed coagulation. By this process it is separated into a fluid of a yellowish colour and slight tenacity, called the *serum*, and into a coagulum, more or less firm, of a dark red colour, called the clot, or crassamentum. By a further examination it is found that this clot consists of a mixture or compound of two principles—the *solid red particles* above mentioned, and a white elastic fibrous matter termed *fibrin*.*

On exposing the fluid, or serous portion of the blood, to the temperature of about 160°, it also becomes a white opaque solid, like the *albumen ovi* similarly treated, and having similar properties. It is not, however, pure *albumen*; for if it be cut into pieces, and placed in a funnel, we shall find, after some hours, a small quantity of fluid ooze from it, which is incapable of undergoing coagulation by heat, and possesses other peculiar properties. This fluid, which is termed the *serosity*, may also

* According to the recent observations of Mr. Bauer, the *fibrin*, or *coagulable lymph*, as it is frequently termed, originally exists in the blood in the state of very minute *white globules*.

be obtained by boiling or well washing the coagulated serum in water. Various opinions have been maintained by different chemists respecting the nature and composition of this portion of the blood; but it is admitted, I believe, by all, to consist of various salts, and some peculiar animal matters. The most recent opinion on the subject is that of Berzelius, who states it to consist of soda holding albumen in solution, of muriates of soda and potash, of lactate of soda, and of a peculiar animal matter which always accompanies the lactates.

Blood then appears to consist of

Water,

Solid red particles,
Fibrin,
Albumen, } From the similarity of their chemical properties, termed by Berzelius, the *albuminous principles* of the blood.

Lactate of soda, and some peculiar animal matters, which, according to Berzelius, always accompany it,

Muriates of potash and soda.

All of which, except the red particles, and perhaps the fibrin, are held in a state of solution whilst circulating in the living body.

The red particles of the blood, when burnt, yield iron, and a small proportion of the earthy phosphates. Albumen and fibrin, when burnt, yield traces of the sulphates and phosphates, but none of iron. Now albumen is known to contain a small proportion of sulphur in some unknown state of

combination; and Berzelius thinks, with great reason, that the sulphates, phosphates, and oxide of iron, obtained by incinerating albumen, fibrin, and red particles of the blood, existed originally in these principles in the states of sulphur, phosphorus, calcium, and iron.

The specific gravity of serum has been stated to be at a mean about 1·028. Dr. Marcet makes it a little higher, or 1·0295. The specific gravity of fibrin appears to be somewhat less, since it usually swims in the serum; whilst that of the red particles is greater, as appears from their sinking in that fluid.

The proportion of these ingredients to one another seems to vary considerably, at different times, in the blood of the same person. The most usual proportion of the crassamentum to the serum is about 1 to 3. Haller fixed the extremes at 1 to 1, and 1 to 4. The proportion of the colouring matter to the fibrin, Berzelius found in one instance to be as 1·8 to 1; but the proportion is evidently very variable.

The *Urine* is a fluid formed from the blood by the operation of the kidneys. I shall not here inquire into the nature of this operation, but proceed at once to describe the urine as it exists in its healthy state. Human urine, when recently voided and still warm, is a transparent fluid of a light amber colour. At this time its odour is

aromatic, and somewhat resembles that of violets; but the taste is bitter and disagreeable. As it cools, the aromatic smell leaves it, and gradually gives place to another, which is peculiar, and well known by the name of *urinous*. In a few days, this is succeeded by another, which has been compared to that of sour milk. At length this also gradually disappears, and is finally succeeded by a fœtid alkaline odour.

Healthy urine, when first voided, reddens litmus paper; and has, therefore, been generally considered as containing a free acid. Its specific gravity has been estimated at a mean to be about 1·0125. It is one of the most heterogeneous fluids known, as the following results of an elaborate analysis by Berzelius will show. 1000 parts of healthy human urine consist of

	Water	933·00
Animal and destructible principles.	Urea	30·10
	Lithic acid	1·00
	Pure lactic acid, lactate of ammonia, and animal matters not separable from these	17·14
	Mucus of the bladder	·32
Alkaline and earthy salts.	Sulphate of potash	3·71
	——— of soda	3·16
	Phosphate of soda	2·94
	——— of ammonia	1·65
	Muriate of soda	4·45
	——— of ammonia	1·50
	Earthy phosphates, with a trace of fluate of lime	1·00
	Silex	·03
		1000·00

Besides these ingredients, which appear to be essential to healthy urine, this secretion in different diseases has been found to contain albumen, fibrin, and the red particles of the blood; nitric acid, various acids formed from the lithic, oxalic acid, benzoic acid, and carbonic acid; xanthic oxide, cystic oxide, sugar, bile, and pus. Perhaps what we have said on the composition of these two fluids will be rendered more striking by the following contrasted tabular view of their constituent principles:

Blood contains	Urine contains, Healthy,	Diseased,
Water.	Water	———
Albumen, fibrin, red particles.	——— ———	Albumen. Fibrin. Red particles.
———	Urea.	———
———	Lithic acid.	———
——— ——— ——— ——— ——— ——— ——— ———	——— ——— ——— ——— ——— ——— ——— ———	Nitric acid. Erythric acid. Purpuric acid. Oxalic acid. Benzoic acid. Carbonic acid. Also xanthic oxide. Cystic oxide. Sugar. Bile.
Lactic acid, and its accompanying animal matters.	Lactic acid, and its accompanying animal matters.	——— ——— ———
——— ———	Mucus of the bladder.	——— ———
———	———	Pus.
Sulphur. Phosphorus. Muriatic acid. Fluorine?	Sulphuric acid. Phosphoric acid. Muriatic acid.	——— ——— ———
———	Fluoric acid?	———
Potash. Soda. Lime. Magnesia. Silex?	Potash. Soda. Ammonia. Lime.	——— ———
———	Magnesia. Silex?	———

1. *Water* forms the basis of the blood and urine, as well as of all animal fluids. When its quantity, however, is raised or depressed above or below a certain standard, it becomes a source of disease, especially in the urine. Thus there is sometimes a simple increase of the watery portion of the urine, while the other principles remain the same, or become much diminished; as in hysteria and various nervous affections. Sometimes the increased flow of urine is accompanied by an increased proportion of a natural ingredient, as of urea, or of unnatural ingredients, as of albumen or sugar. On the other hand, the proportion of water in the urine is not unfrequently very much diminished below the natural standard, as in the various forms of urinary suppression. Sometimes, when the cause of this suppression is mechanical, the urine is simply diminished in quantity, while its composition and quality remain the same: at other times the suppression is connected with deranged action of the kidneys; and in these cases, while the proportion of water is diminished, those of the other ingredients are relatively much increased, as happens in various forms of gravel and calculus. *Watery* urine is usually limpid and colourless, and may be readily known by its low specific gravity, and the unnatural quantity in which it is voided.

2. *Albumen, fibrin, and the red particles,* which constitute the great bulk of the matters existing in the blood, are never met with in healthy

urine. But in certain diseases, as in some varieties of dropsy, the urine becomes albuminous; and occasionally, not only albumen, but even fibrin and red particles, pass through the kidneys unchanged. It may be proper, however, to observe, that the albuminous matters found in the urine are usually more analogous to those of the chyle than of the blood, as will be more particularly shown hereafter.

Urine containing chylous albumen is generally pale coloured, and, on being exposed to a temperature of about 150°, becomes opaque, and deposits this principle in a coagulated state. The effect is increased by the addition of an acid, especially the nitric acid; but the most delicate test of albumen is dilute acetic acid, and the prussiate of potash.

Bloody urine is of course likewise albuminous; but is always more or less of a dark colour.

3. *Urea.* This principle is peculiar to the urine, and is formed by the action of the kidney from some of the constituents of the blood, perhaps the albumen. The colour and other sensible qualities of the urine were formerly ascribed to this principle; but Berzelius showed, many years ago, that urea was colourless;* and in 1817, a paper was published by me,† in which it was shown that this principle is not only colourless, but has no

* View of the Progress and Present State of Animal Chemistry, p. 101.

† Med. Chirurg. Transactions, viii. p. 529.

remarkable smell nor taste. Notwithstanding this, however, nothing is more common in conversation, and even in books, than to find the old opinion maintained. To counteract this error, therefore, I think it proper to re-publish my description here.

"Urea most commonly assumes the form of a four-sided prism. Its crystals are transparent and colourless, and have a slight pearly lustre. It leaves a sensation of coldness on the tongue like nitre. Its smell is faint and peculiar, *but not urinous.* It is neither sensibly acid nor alkaline. It undergoes no apparent change on exposure to the air, except in very damp weather, when it slightly deliquesces, but does not seem to be decomposed. Exposed to a strong heat, it melts, and is partly decomposed, and partly sublimes, apparently unaltered. The specific gravity of its crystals is about 1·350.

"Water at 60° dissolves more than its own weight of urea; and the solution exposed to the air for several months underwent no change. Boiling water dissolves any quantity of it whatever, and the urea does not appear to suffer any change at this temperature. Alcohol (specific gravity ·816), at a mean temperature, dissolves about 20 per cent.; and, at a boiling temperature, more than its own weight; and the urea separates, on cooling, in a crystalline form. It is very sparingly, if at all,

soluble in sulphuric ether, or the essential oil of turpentine, though these fluids are rendered opaque by it.

"The pure fixed alkalies and alkaline earths decompose it when heat is applied and water present. The result is chiefly carbonate of ammonia. It unites with most of the metallic oxides. Its combination with the oxide of silver is greyish, and detonates on being heated, and the oxide is reduced. It does not seem, however, to be alone capable of decomposing any metallic salt; but in order to effect the union, the aid of double affinity is necessary. It combines with nitric acid, and forms a crystalline compound, but sparingly soluble in water, and which has been long known to chemists. It forms also a similar compound with oxalic acid. In neither of these compounds are the acids neutralized."

An excess of urea in the urine seems to be characteristic of a peculiar form of disease, to be described hereafter. The mode which I commonly use to detect an excess, is to put a little of the urine into a watch-glass, and add to it carefully nearly an equal quantity of pure nitric acid, in such a manner that the acid shall subside to the lower part of the glass, from its greater specific gravity, and allow the urine to float above it. If spontaneous crystallization takes place, an excess of urea is indicated; and the difference of excess can be

inferred, near enough for practical purposes, by the greater or less time which elapses before the crystallization takes place, which time may vary from a few minutes to two or three hours. Such urine is commonly, but not always, of a pale colour.

I know of no disease characterized by a diminished proportion of urea. It is true, that in diabetes, and some other diseases of the urine, very little urea is present; but the same holds with respect to the other principles, many of which are deficient in such urine as well as urea. Hence the absence of urea can scarcely be considered as characteristic. It has been said, also, that in hepatitis this principle is deficient; but this by no means accords with my experience. In fact, I am disposed to assert that generally in this disease there is an excess of urea in the urine, rather than a deficiency.

4. *Lithic acid.* Lithic, or uric acid, is not found in the blood; but it appears to be a constant constituent of healthy urine, in which fluid it exists in a state of solution at all ordinary temperatures. In a pathological point of view, this acid is, perhaps, of more importance than any other. I shall therefore enter rather minutely into its history under the two following heads: *a.* Its mode of existence in healthy urine; *b.* The modifications which it is capable of undergoing.

a. It has been before stated, that fresh human

urine reddens litmus paper, and that in consequence it has been supposed to contain a free acid. In inquiring into the cause of this acidity, Berzelius remarks, "as by the laws of chemical affinity the acids of the urine will unite with any alkali that may be present, and saturate themselves with it in the order of the force of their respective affinities, it must follow, that when the quantity of alkali is insufficient to saturate all the acids present, the weakest acids must be those that will remain uncombined and will give the urine its acid properties. These, therefore, must be the *lactic* and the *uric*."*

Thus it appears to be the opinion of this eminent chemist, that the lithic acid exists in the urine, at least in part, in a pure state, and, consequently, that it is held in solution merely in virtue of its solubility in water; and this I believe is the general opinion upon the subject. On reflecting upon this opinion, however, it seemed to me very improbable, for the following reasons:—First. According to the analysis of Berzelius, 1000 parts of healthy urine contain in solution one part of lithic acid; but Dr. Henry states, that one part of lithic acid requires, at 60°, at least 1720 parts of water to dissolve it. Now, how are we to reconcile these two statements, on the sup-

* Med. Chirurg. Trans. iii. p. 257.

position that lithic acid exists in the urine in a pure state? Secondly. The addition of any acid to the urine, even the carbonic, as is well known, throws down the lithic acid. How is it possible to explain this fact, except on the supposition that the new acid combines with something retaining the lithic acid in solution, which, being set at liberty, is thus incapable of remaining any longer in solution, and is consequently precipitated in the solid form. Thirdly. There is no instance known in which lithic acid is secreted in a pure state: birds, serpents, &c. always secrete it in combination with ammonia; in the gouty chalk-stone it is secreted in combination with soda. To suppose, therefore, that the human kidney secretes lithic acid in a pure state, is to suppose an exception to a law which appears to be very general. Lastly. The lithate of ammonia often *does* exist in large proportions in human urine, as is proved by the fact that many of the amorphous sediments consist chiefly of that compound, as will be shown hereafter. On reflecting upon these circumstances, I was induced to make some experiments on the subject, the result of which has been such as to render it probable that the lithic acid in healthy urine exists in a state of combination with ammonia, and that in reality this fluid contains no uncombined acid at all.

Thus, with respect to the solubility of lithic

acid in water, I find that this principle, when pure, requires about six times more water to dissolve it than has been stated by Dr. Henry, or at least 10,000 times its own weight at 60°; a fact which adds much to the improbability of the common opinion. On the contrary, the lithate of ammonia requires only about 480 times its weight at the same temperature; and if to the solution any acid be added, the lithate is immediately decomposed, and the acid precipitated in the solid state; just as happens to the urine when similarly treated. Further, the lithate of ammonia, when in solution, reddens litmus paper; and what is singular, and scarcely would have been expected, is likewise capable of existing in the same solution with a solution of the super-phosphate of ammonia, which, as is well known, has likewise the property of reddening litmus paper. Now, as the phosphate, or rather super-phosphate of ammonia exists in healthy urine, this fact, taken in conjunction with the others, enables us to account very satisfactorily for the two important points in question, namely, the property of reddening litmus paper possessed by that fluid, and also for the permanent state of solution in which the lithic acid is held in it; both of which appear inexplicable on the common opinion. Further, if we evaporate healthy urine slowly, as, for example, under the receiver of an air-pump, with sulphuric acid, the lithate of ammonia is deposited on

the sides of the vessel in abundance, in the form of an amorphous sediment; whereas, if this acid existed in the urine in the pure state, it should be deposited in a pure crystalline form. Lastly, the supposition that the lithic acid exists in the urine in the state of lithate of ammonia, will enable us to throw considerable light on the phenomena presented by the urine in different diseases, as will be shown hereafter.

b. On the changes which lithic acid is capable of undergoing.—1. When nitric acid, diluted with about an equal bulk of water, is poured upon pure lithic acid, and a moderate heat is applied, an effervescence takes place, and the lithic acid is dissolved. If we concentrate this solution by a gentle evaporation, we obtain transparent colourless crystals, which have been found to constitute a peculiar acid, and have been hence named by M. Brugnatelli, who first described them, *erythric acid.** 2. If into a strong solution of these crystals in water, whilst boiling hot, we carefully drop pure ammonia, the solution acquires a beautiful purple colour, and crystals of *purpurate of ammonia* speedily begin to form and subside. 3. If these crystals are treated by means of potash and sulphuric acid, in a manner formerly described by me,† pure *purpuric acid* is obtained in the form

* Giornale di Fisica, 1818. † Philos. Trans. 1818, p. 420.

of a yellowish or cream-coloured powder. Such is a part of the series of changes which lithic acid is capable of undergoing, and apparently does undergo, in the human body in different diseases, either by the action of the kidney, or the natural operation of the various principles existing in the urine upon one another, as we shall now attempt to explain.

The amorphous, or uncrystallized, sediments, usually denominated *pink* and *lateritious* sediments, and supposed by Proust to constitute a peculiar acid, which he named the *rosacic*, have been long known. These I find, by well-known methods, to consist essentially of the *lithate of ammonia*, and sometimes of the *lithate of soda*. They owe their colour partly to the colouring matter of the urine, to be described hereafter, and partly (in some instances apparently almost entirely) to the *purpurates of the same bases.* I acknowledge that it is difficult, or indeed almost impossible, to prove these latter points by direct experiment; but the following observations will, I think, place their truth beyond a doubt.

When pure lithate of ammonia is diffused through fresh healthy urine, it attracts to itself a portion of the colouring matter of that fluid, and falls down in the state of a yellowish powder. But if the least quantity of a solution of an alkaline purpurate be added to the urine, such is the affinity of the lithate of ammonia for this

colouring substance, that it immediately attracts the purpurate to itself, and assumes the form of a red or pink powder, more or less deep, and varying in tint according to the purpurate employed. From these observations it is evident that, if ever the purpurates exist in the urine when amorphous sediments are precipitated from it, these sediments must necessarily become more or less tinged by them. To establish the point in question, therefore, we have now only to render it probable that the purpurates do exist in the urine under certain circumstances of disease.

I have shown elsewhere,* that the pink and lateritious sediments occasionally contain nitric acid in some peculiar state of combination. Now the purpuric acid, or rather the purpurate of ammonia, is only lithic acid modified by the action of the nitric acid. If, therefore, nitric acid and lithic acid exist in the urine together, it is exceedingly probable, or rather certain, that at the temperature of the human body, a portion of the lithic acid will be acted on by the nitric acid, and converted into *purpurate of ammonia.* These facts, then, especially when taken into account with the absolute identity of tint, are, I think, sufficient to convince every impartial reader that the pink amorphous sediments owe their colour chiefly to

* Med. Chirug. Trans. ix. p. 481.

the alkaline purpurates, though from the circumstance of their being merely as it were dyed with the purpurates, these cannot be separated, and thus actually be demonstrated to be present.

In some forms of disease the urine does really contain an uncombined acid, as will be pointed out hereafter; and in this case the lithate of ammonia is decomposed, and the lithic acid deposited in a crystalline form, and nearly pure; thus constituting the disease called *gravel.*

The lithic acid and its compounds may be easily detected by the above singular properties. When they exist abundantly in the urine, this fluid is almost invariably of a deep colour; and if at the same time a free acid be present, the urine is for the most part unusually transparent, and free from mucus.

8. *Oxalic acid.* This acid is neither found in the blood nor in healthy urine. It is secreted in some forms of disease; but whether in a free state is not known, as it always occurs in combination with lime, which, from its great affinity for that earth, it may be supposed to get from the urine. The *oxalate of lime,* in some rare instances, forms gravel, and not unfrequently calculi. When burnt, it yields quick-lime; or if boiled with an excess of sulphuric acid, the oxalic acid may be obtained in a separate state; and thus be readily distinguished by its properties.

9. *Benzoic acid.* This acid does not exist in the blood nor in healthy human urine. It has been stated by Scheele to exist occasionally in the urine of children; but this is doubted by Berzelius, and I think with great reason, as I have never myself met with an instance of its occurrence. Proust informs us that this acid may be obtained from the urine in which it exists by concentration. It may be easily recognized by its proneness to assume the crystalline form and by its volatility, properties not possessed in common by any elementary principle existing in the urine.

10. *Carbonic acid.* This acid has been stated by Mr. Brande to exist in the human urine; but the opinion was called in question by Berzelius. Some late experiments, however, of Dr. Marcet, render it probable that under certain circumstances carbonic acid really exists in this fluid;* and I have myself seen small calculi discharged from the bladder composed principally of the carbonate of lime. The existence of this acid in the urine may be shown by placing it under the receiver of an air-pump, with lime water, in the manner described by Dr. Marcet.

11. *Xanthic oxide.* This name has been given by Dr. Marcet to a substance constituting the chief bulk of a small renal calculus. It does not

* Essay on Calculous Disorders, page 159, first ed.

exist in the blood, and has never, as far as I know, been observed in the urine but in one instance, and consequently must be extremely rare. It seems to be nearly allied to lithic acid. It derives its name from its property of yielding a lemon *yellow* colour when treated with nitric acid, a property by which it may be distinguished.

12. *Cystic oxide.* This substance is peculiar to the urine, and sometimes forms entire calculi. Such calculi are rare; and no instance is on record in which it has been observed in any other state. Cystic oxide may be distinguished by its solubility in acids and alkalies, and by the characteristic odour it yields when burnt.

13. *Sugar.* This principle is not found in the blood even of individuals labouring under diabetes, in whose urine it exists in the greatest abundance; nor is it a constituent of healthy urine. The sugar of diabetic urine differs in its appearance from common sugar, and approaches more nearly to the sugar of grapes. This principle may be suspected to exist in *pale* urine when its specific gravity is above 1·030. A large quantity of sugar may, for the most part, be readily discovered by the sweet taste which it imparts to that fluid; but when in small quantity, its presence is with difficulty detected. Urine containing a large proportion of sugar, is generally pale coloured, and its natural ingredients are much diminished in quantity.

14. *Bile.* In certain diseases, and particularly jaundice, this fluid seems to find its way into the urine in small proportions. Such urine is generally of a deep brownish red colour when in considerable quantity, and viewed by transmitted light; but when examined in small quantity, it has sometimes a greenish appearance. A piece of white linen is well known to be stained yellow by such urine; and the addition of muriatic acid renders it green. Of the two, the latter appears to be the most delicate and unequivocal test.

15. *Lactic acid, and its accompanying animal matters.* These principles, according to Berzelius, exist both in the blood and the urine; thus passing through the kidney without undergoing any change. According to this eminent chemist, also, it is chiefly to these principles that the urine owes its sensible qualities of smell and colour; and he ascribes likewise principally to the presence of pure lactic acid its property of reddening litmus paper, as before stated. I would not be understood to deny either of these points; but I confess I have never been able to satisfy myself of them so completely as I could wish. We have seen above, that the property of reddening litmus paper possessed by the urine, may be accounted for on other principles: and as to the colour of the urine, I have stated that this appears to be sometimes owing, in part at least, to the presence of

the purpurates. I admit, however, the existence of a colouring principle in the urine, besides the purpurates; but, as far as I know, it has never been obtained in a separate state.* The colour of

* I have sometimes thought that a great many of the phenomena presented by the colouring principle of the urine cannot be explained, except on the supposition that it is of two distinct kinds. Thus, if we add pure lithate of ammonia to healthy urine, we find that it invariably acquires a certain colour, more or less deep, and precisely of the usual tint of lithic acid calculi. If we perform this process repeatedly, by adding fresh portions of the lithate of ammonia to the same urine, we find that the lithate of ammonia is rendered paler and paler every time, and at length ceases to acquire colour: yet, what is singular, that the apparent colour of the urine is very little different from what it was at first. Now, how are we to explain this circumstance, except upon the supposition that there are at least two species of colouring matter in the urine; one of which has an affinity for the lithate of ammonia, and the other none at all? It is to the first of these species of colouring matters that lithic acid calculi appear chiefly to owe their colour; and the tint is very peculiar and characteristic. The other species of colouring matter appears to be ill defined, and of uncertain composition: yet both of them are evidently somehow or other connected with lithic acid, as they soon disappear after that principle becomes deficient in the urine, as in diabetes, when the phosphates are deposited in excess, &c. in which diseases the urine is invariably of a pale colour. Hence it is not improbable that these different colouring matters are intimately connected with one another, as well as with lithic acid.

Brugnatelli has lately made some remarks on the co-

the urine, however, is liable to be modified by the nature of the ingesta, and a variety of other circumstances.

The cause of the peculiar *smell* of the urine has never been explained; but it is probably connected with some undefinable compound into which, if I am not mistaken, sulphur, phosphorus, and azote, largely enter.

16. *Mucus.* This principle, of course, does not exist in the blood, but is derived from the mucous membranes lining the urinary passages and bladder. In a pathological point of view, this mucus is of the utmost importance, especially when the urine deposites the phosphates; in which case the mucous membranes, more particularly of the bladder, are usually in a high state of irritation, or actual disease. In such cases a large quantity of an unnatural adhesive mucus is secreted, which becomes intimately intermixed with the earthy matters, and by acting as a sort of cement, renders them more liable to adhere together, and form concretions. There is no chemical test which will enable us to distinguish between healthy and diseased mucus; but a great deal of important information may be derived from the different appearances assumed by this principle. Unfortunately, however, by far the greater part

louring matters of the urine; but they are very little to the purpose. Giornale di Fisica, i. p. 132.

of these appearances will not admit of description, but can be learnt only by personal experience.

17. *Pus.* This principle is sometimes met with in the urine. When accompanied by blood, it may in general be concluded to be derived from an abscess, or some similar affection. There are, however, exceptions to this; and in forming our opinion, as in all similar cases, other circumstances should be taken into account. Mucus and pus appear to run into one another by imperceptible grades, and almost always exist together in the same urine: hence they are distinguished from one another with great difficulty. A principle so nearly allied to pus is derived from the mucous membrane of the urethra, in certain diseases, that it cannot be distinguished from purulent matter by any means at present known. Thus, like pus, it is composed of *particles;* and when diffused through a fluid, renders it opaque, and at length subsides to the bottom in a state more or less pulverulent. The muco-purulent matter in question, however, is seldom accompanied with blood; and this circumstance, and the history of the disease, will commonly enable us to distinguish its origin.

18. *Sulphur. Sulphuric acid. Sulphates.* Sulphur exists in the blood in minute quantity, apparently as a constituent of its albuminous principles; but sulphuric acid is not met with in that fluid. Sulphur also appears to exist in some peculiar

state of combination in the urine; but by far the greatest proportion of this principle exists in the urine as sulphuric acid, in combination, of course, with the alkaline matter present. I do not find that sulphuric acid has ever been suspected of being concerned in the production of any morbid condition of the urine; and I believe it never has been observed to form (in combination with lime, for instance,) any sensible proportion of urinary calculi or gravel. This would seem to show that variations in the quantity of this principle are more limited than those of some other principles found in the urine, which is probably the case. I think, however, that I have seen a case where the sulphuric acid, in a free state, acted as a precipitant of the lithic acid. The gentleman in whom this occurred was corpulent, and subject to eructations, which he compared to *bilge water*, and which probably contained sulphuretted hydrogen. The presence of sulphuric acid in the urine may be known by its yielding a precipitate insoluble in nitric acid, on the addition of the nitrate of barytes.

19. *Phosphorus. Phosphoric acid. Phosphates.* Phosphorus, like sulphur, appears to exist in minute quantity both in the blood and urine; and probably, like that substance also, as an element of some of the constituent principles of these

fluids. Phosphoric acid exists in the blood in very minute quantity, if at all; but in healthy urine it is met with, according to the best analysis, in about the same proportion as sulphuric acid. In a pathological point of view, phosphorus and its compounds particularly claim our attention. I am not acquainted with any disease connected with the simple absence of phosphorus and its compounds from the urine; though the existence of such a disease is not improbable, when we consider that health is always accompanied by the due separation of a certain proportion of these principles from the economy. On the contrary, cases where this acid exists in the urine in a free state, and apparently acts as a precipitant of the lithic acid, are by no means uncommon. Phosphoric acid, however, becomes most formidable when the earthy bases, lime, and magnesia, are secreted in greater abundance than natural; which, by combining with the acid, form insoluble phosphates; and thus constitute by far the most distressing species of gravel and calculus. In healthy urine this acid, like the sulphuric, appears to exist principally in union with potash, soda, and ammonia, and partly, perhaps, with lime and magnesia; the different salts being, from the excess of acid, in the state of superphosphates. Phosphoric acid is shown to exist in the urine by its yielding, with the nitrate of barytes, a

precipitate soluble in nitric acid, and again precipitable from that acid, by ammonia, without decomposition.

20. *Muriatic acid. Muriates.* The muriatic acid, in combination with soda and potash, occurs both in the blood and in the urine; thus appearing to pass through the kidneys unchanged. This acid, and its compounds, in a pathological point of view, are, perhaps, to be considered as the least important existing in the urine—no disease arising from their excess or defect being at present known. The muriatic acid may be proved to exist in the urine by the white, curdy, insoluble precipitate which is formed when the nitrate of silver is added to it after the sulphuric and phosphoric acids have been renewed by the nitrate of barytes.

21. *Fluoric acid* is said by Berzelius to exist in the urine in small quantity, combined with lime; but, as far as I know, this observation has not been verified by any other chemist. It may be detected by its property of corroding glass.

22. *Soda. Potash. Ammonia.* The two fixed alkalies, as before stated, exist both in the blood and the urine, in union with the sulphuric, phosphoric, muriatic, and, according to Berzelius, the lactic acids. Ammonia exists only in the urine, apparently in combination with the muriatic, phosphoric, and lithic acids. No disease is known to arise from the excess or defect of the fixed alkalies; but the deposition of the earthy phosphates in the

urine is almost always accompanied, if not immediately produced, by an excess of ammonia. Hence, in a pathological point of view, this is a principle of the greatest importance. The apparent source of the excess of ammonia is the urea, as will be more particularly pointed out in the next paragraph. The alkaline salts may be obtained from the urine by evaporating it to dryness. There is no test for soda; but its salts may be recognized by their form. Potash may be known by the insoluble precipitate it forms with the muriate of platinum; and ammonia by its volatility, and peculiar odour.

23. *Lime. Magnesia. Silex.* Lime and magnesia exist both in the blood and the urine; but in very different states. In the blood, they appear to enter, perhaps as elements, into the composition of the albuminous principles; and hence cannot be obtained without combustion: in the urine they occur chiefly in the saline state, apparently, as before observed, in union with the phosphoric acid. I am not acquainted with any disease characterized by a deficiency of these earths in the urine; but the most distressing and dangerous form of calculous complaints is connected with, and, indeed, immediately arises from, their *excess*, namely, the deposition of the earthy phosphates. In this form of the disease, the earthy bases seem to be separated in a much greater proportion than usual; while the quantity of phosphoric acid is relatively

diminished. This deficiency of phosphoric acid, however, does not seem to arise from a deficiency of phosphorus, but from some defect in the oxygenating operation of the kidneys, by which that principle is permitted to pass through them unchanged: for the urine under these circumstances often seems to contain, in some unknown state of combination, even more phosphorus than natural. The urea, also, in this form of disease, exists in great abundance; but in some peculiar and apparently imperfect state, by which it is rendered extremely prone to decomposition, and liable to be converted into the carbonate of ammonia. Hence, the urine in this disease is either naturally alkaline, or speedily becomes so; and this excess of alkali contributes to the rapid union of the earthy bases with the phosphoric acid present, and their consequent deposition in the form of phosphates. Urine containing an excess of the phosphates, is generally of a pale colour.

The phosphates of lime and magnesia may be precipitated from the urine by ammonia: the phosphate of lime usually appears in the state of an amorphous powder; the phosphate of magnesia, which combines with the ammonia, and thus forms a triple phosphate of magnesia and ammonia, in the form of minute crystals.

Silex has been stated to constitute urinary sediments, and even to form a part of urinary calculi

in some instances: but this assertion requires to be better authenticated than it is at present, before it can deserve credit. This earth, however, ordinarily exists in the urine in minute quantity, according to Berzelius; but he supposes it to be derived from the water which we drink, which is not improbable. It may be readily distinguished by its insolubility in all acids except the fluoric, and by its other well-known refractory properties.

From the preceding sketch, we find that the most striking differences between the blood and the urine, is the complicated nature of the latter. The astonishing variety of substances formed from such a paucity of materials, naturally leads us to reflect upon the vast extent of the operation of the kidneys. On considering, however, a little more attentively the nature of the operations of these organs, we shall find, as Berzelius has justly remarked, that *acidification* constitutes the chief feature in them. Thus, the sulphur and phosphorus of the blood are converted by the kidneys into sulphuric and phosphoric acids: a new acid, the lithic, is generated altogether, &c. Such, then, evidently is the natural and healthy operation of these glands. We find, however, that in certain forms of disease, this acidifying tendency is carried to excess, and nitric acid, oxalic acid, &c. are pro-

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duced. On the other hand, it is occasionally suspended, diminished, or altogether subverted; and unchanged blood, or albuminous matter; neutral substances, as urea, or sugar; or even alkaline substances, as ammonia, lime, and magnesia, are separated in abundance; and the phosphorus and sulphur at the same time pass through the kidneys without being acidified. With respect to the character of the diseases attending these states of the urine, it will be generally found, that when acids are generated in excess, the urine is commonly small in quantity, and high coloured, and the disease inflammatory: when neutral or alkaline substances, the urine, on the contrary, is generally pale coloured, and larger in quantity; and the diseases are those of irritation and debility.

With respect to the mode in which all the different substances existing in the urine are naturally combined, it is impossible to state any thing with certainty, except generally that the several acids divide the alkaline bases among themselves in the order of their respective affinities and quantities. The greatest difficulty which occurs among the salts, is with respect to the phosphoric and lithic acids and their compounds. There can be no doubt, however, as formerly stated, that the whole of both of these acids are in combination with some base or bases; otherwise the lithic acid could not be retained in solution. Yet the solution of

these compounds reddens litmus paper very strongly; showing that the acids, though in a state of *combination*, are not in a state of *neutralization* (two very different things, though frequently confounded with each other); and we can only explain this by supposing that the affinity of the elements of the different salts are so balanced, that the ammonia of the super-lithate of ammonia, for example, is held too firmly in combination by its acid to be separated by the phosphoric acid of the super-phosphates.

ON THE

DISEASES OF THE URINE.

THE conditions of the animal economy, connected with the different morbid states of the urine, are more intimately related than may at first sight appear: hence there is some difficulty, at least in the present state of our knowledge, of devising a perfectly unexceptionable mode of arranging them. Perhaps the most simple and obvious principle of arrangement is that founded upon the *solubility* or *insolubility* of the principles met with in the urine. This I have adopted; and, accordingly, have divided my subject into the two following sections:—

I. *Diseases in which principles soluble in the urine are morbidly deranged in quantity or quality.*

II. *Diseases in which principles insoluble in that secretion are similarly deranged.*

By this arrangement, we shall, indeed, as will be found hereafter, separate one or two diseases which appear to be closely connected with one

another; but this defect, the consequences of which can be easily obviated, appears to me more than counterbalanced by the general conveniency of the arrangement in other respects.

Under the first of the above general divisions will be considered,

1. *Various forms of albuminous urine.*

2. *Anonymous diseases, in which an excess of urea is the characteristic symptom.*

3. *Diabetes.*

Under the second,

All the various forms of gravel and calculus.

I wish to be understood, that I by no means consider the above list to comprehend *all* the morbid conditions of the urine. There are certain others connected with the soluble principles of that secretion, which do not hitherto appear to have been observed; and of which, although I have little doubt of their existence, my knowledge is too imperfect to lay before the public. I shall, therefore, pass them by entirely at present, premising, in this place, in their stead, a few general remarks only upon the conditions of the system usually accompanied by a diminished or increased flow of urine; with the view of drawing the attention of my readers more particularly to these important *symptoms.**

* The only constant circumstance attending a diminished or increased flow of urine, is obviously a *diminished* or *in-*

A diminished flow of urine accompanies active inflammation, and an inflammatory state of the system in general. The urine is invariably of a deep colour.

An increased flow of urine, or *Diuresis*, very constantly accompanies those diseases connected with a peculiar state of nervous irritability, as hysteria. It may be also produced by certain passions of the mind, as fear. Lastly, it may be induced by local irritants acting on the urinary organs themselves. In these cases the urine is always of a pale colour.*

creased separation of water by the kidney. Hence the above symptoms, strictly speaking, relate to the *watery portion* only of the urine, without any regard to its other principles; and this is the sense in which I wish them to be understood.

* I do not mean to assert that these are the only conditions of the system attended by a diminished or increased flow of urine. It is well known that the quantity of urine is liable to be varied by the temperature of the atmosphere, and by many other causes of an extraneous or mechanical nature, whose *modus operandi* is sufficiently obvious. With respect to the standard quantity of urine voided by a healthy adult in twenty-four hours, it has been variously estimated. Haller fixed it as high as 49 ounces. Dr. Bostock thinks the estimate of Rye more correct, who fixed it at 40 ounces. I am disposed to think that even this estimate is too high, and that 2 lb. or 32 ounces, is a fair average, taking the whole year together. It is obvious, however, that there can be no *universal* standard in such a case as this; and consequently that every individual must form his estimate from his own.

Thus, generally speaking, nothing can be more opposite than the conditions of the system, and consequently the principles of practice, indicated by a diminished or increased flow of urine. Hence, they are symptoms of primary importance in all diseases in which the urine is concerned; and, whatever may be the disease, seldom fail, as the following pages will show, of furnishing us with a clue to the principles upon which it is to be treated.

SECTION I.

ON THE DISEASES IN WHICH PRINCIPLES SOLUBLE IN THE URINE ARE MORBIDLY DERANGED IN QUANTITY OR QUALITY.

CHAP. I.

Diseases in which the presence of an albuminous principle is the characteristic symptom.

It is not my object to treat here of urine rendered albuminous by the presence of blood, but of a peculiar condition of that secretion, in which it is found to contain one or more principles, usually more resembling those met with in the chyle than in the blood. These albuminous principles sometimes exist in the urine in very large proportion, in which case it undergoes a kind of spontaneous coagulation; but most generally their quantity is small, when they are held in solution in it. In these cases the urine is almost invariably pale coloured, and of moderate or low specific gravity. Occasionally it is opalescent when voided; and in all instances, on being exposed to the action of heat, it becomes opaque, and deposits flakes of albuminous matter. It is prone to decomposition, especially what is

passed some time after meals, which is generally more loaded with albuminous matter, and consequently possesses all the above properties in a more eminent degree. Sometimes what is voided at this time throws up a sort of creamy matter upon its surface, after standing some time. This affection of the urine exists in every possible degree, from barely perceptible traces of an albuminous principle, to perfect chyle, or blood. The slighter cases are not uncommon, and occur in dropsy, and various other affections having apparently no common character. Sometimes the urine is constantly albuminous for years; at other times it becomes so occasionally only; and certain individuals appear much more liable to this affection than others.

Urine rendered albuminous by blood, may, I think, be readily distinguished from the albuminous urine in question, by the presence of the red particles of the blood, which subside to the bottom of the vessel in which the urine has been allowed to stand for some time. This is so constantly the case, that I do not think I have ever met with an instance of the urine decidedly rendered albuminous by blood, without finding more or less of the red particles in it. Bloody urine is also, from the same cause, more or less of a dark colour.*

* It would appear, from the observations of Dr. Wells, and others, that in the dropsy which sometimes follows scarlatina, as well as occasionally in some other instances of dropsy, *real*

There is also a species of mucus sometimes found in the urine, and derived, I believe, from the prostate gland, when in a state of irritation or disease, which is capable of undergoing a sort of coagulation by heat, and which, I have little doubt, has been sometimes mistaken for albumen. This, however, may be readily distinguished from albumen, by its being coagulated by dilute acetic acid, which albumen is not.

The symptoms usually attending this albuminous condition of the urine are those of irritability. In slighter cases there is generally a frequent desire to pass water, and for the most part decided diuresis. I have never known albuminous urine attended by positive pain, though the patient, for the most part, complains of certain indescribable sensations, which render him conscious that all is not right. In severe cases, where the drainage from the system is greater than natural, there are, as might be expected, an inordinate craving for food, and other symptoms somewhat resembling diabetes.

The following interesting case presents an extreme instance of this affection. As such are very

blood is met with in the urine. I have had no good opportunity of verifying this remark; but if it be well founded, it must, I think, indicate a disease much greater in degree, if not altogether different, from those under consideration. Transactions of a Society for the Improvement of Medical and Surgical Knowledge, iii. 167, et seq.

rare, I shall give rather a minute account of the urine in its different states:—The patient was a married woman, about thirty years of age. The disease first made its appearance about twelve months before, and proceeded gradually. Her appetite was greater than natural, and she had some other symptoms of diabetes; but her general health seemed very little affected; and almost the only inconvenience she experienced was a constant difficulty of passing her water, owing to the coagula which formed in the bladder blocking up the urethra.

I received three specimens of this woman's urine, namely, one voided in the morning, another a little after breakfast, and a third in the evening.

The first specimen, voided in the morning, consisted of a solid jelly-like mass, or coagulum, of a pale amber colour. This coagulum was of an extremely delicate texture; and, on being submitted to a gentle pressure, or even allowed to drain, parted with a large proportion of a serous fluid of the colour above-mentioned, and at the same time became exceedingly reduced in bulk, and assumed the appearance of a red fleshy-like mass of a fibrous texture, and which, upon examination, was found to have all the properties of the fibrin of the blood, mixed with a few of the red particles of the same fluid. The specific gravity of the serous portion was 1·019. Its smell was very faintly urinous.

It did not affect litmus or turmeric paper; and although it contained a larger proportion of albuminous matter coagulable by heat, it yielded distinct traces of the presence of urea.

The second specimen, voided after breakfast, resembled the first in its general characters, but differed from it in some minor particulars. Thus the serum was more of a whey colour, the fibrous coagulum was less, and more compact and firm, and contained, entangled in its texture, a larger proportion of the red particles of the blood. The specific gravity of the serous portion was only 1·0124. It contained, however, a considerable proportion of albuminous matter, though it did not coagulate by heat. It contained also a sensible proportion of urea.

The third specimen, voided in the evening, after an early dinner taken about noon, was the most remarkable, and so closely resembled chyle in all respects, that I am doubtful, if it had been brought to me as a specimen of that fluid, whether I should have discovered the imposition. It consisted of a solid coagulum of a white colour, and assuming the shape of the vessel, like blanc-mange. On being submitted to a gentle pressure, and permitted to drain, the residual solid portion was, like that of the others, small in quantity, but whiter than the coagula of the other specimens. It was, however,

intermixed with strings of a firmer consistence, and of a red colour. The serous portion was white and opaque, like milk; and on being heated, and permitted to stand at rest for some time, threw up a substance upon its surface very like the cream of milk, and which, like that substance, was found to contain a considerable proportion of a butyraceous principle. Its specific gravity was 1·0175; and its smell was not urinous, until after it was concentrated by evaporation, when it became slightly so; and in this state yielded faint, though distinct, traces of the presence of urea. It was not coagulable by heat, though it contained abundance of albuminous matter, chiefly, however, in that state in which it exists in the chyle, and which I have elsewhere denominated *incipient* albumen.* One hundred grains of this serous fluid, evaporated to dryness, left about seven grains, half a grain of which only was soluble in alcohol, and consisted of urea, a little fatty matter, and the other principles commonly found in all animal fluids; while the remaining six grains and a half consisted chiefly of the imperfect albuminous and fatty principles above-mentioned, with some salts. It burnt with a flame, yielded an odour something like that of cheese, and left a coal difficult

* Annals of Philosophy, xiii. p. 20.

to incinerate, but which, when burnt, was found to contain a considerable proportion of earthy salts, chiefly of phosphate of lime.

I had an opportunity of examining this woman's urine after fasting twenty-four hours. The coagulum was now much smaller in bulk, and seemed to contain more red particles. The serous portion was nearly transparent, and possessed in a considerable degree the colour and other sensible properties of the urine. Its specific gravity was 1·021; and it was found to contain abundance of urea, and a large proportion of more perfect albuminous matter than either of the other specimens.

The above remarkable case occurred to my friend Dr. Elliotson,* to whom I was indebted for the opportunity of examining the urine. From particular circumstances, no plan of medical treatment was adopted; and the subsequent history of the patient is unknown, which is much to be regretted.

By way of illustrating slighter cases of this form of disease, I shall relate one which occurred to me several years ago, before I had formed the opinion that chyle, and not blood, is occasionally the source of the albuminous principle.

The patient was a man 64 years of age, frequently dyspeptic, and subject to bilious obstruc-

* Vide Notes to his Translation of Blumenbach's Physiology, p. 277, third ed.

tions; a martyr to gout; and had numerous lithic concretions both in his hands and feet. His urine was first examined under a paroxysm of gout, before any œdematous swelling had taken place, and found albuminous in a great degree. Its specific gravity was 1·0141. It became turbid at 120°; and as the temperature advanced, formed heavy flakes. It contained very little saline matter, and possessed only slight traces of urea or lithic acid. The urine has been examined several times since that period, and invariably found albuminous, even when the patient was in his best health, and when his appetite and digestion, though never entirely correct, have appeared to be very near the standard of health. It has always been secreted in abundant quantity, and its specific gravity has varied from 1·0041 to 1·0076. I found that this man's urine, after having been kept some days in the bottle, acquired the smell of sour whey, and very strongly reddened litmus, evidently from the developement of acetic acid. The animal matter present differed from albumen, and approached in its properties to curd, though it was evidently a substance distinct from either: in short, it had all the properties of the imperfect albuminous matter found in chyle.

The above case occurs in the first edition of Dr. Scudamore's book on Gout, &c. published in 1816; and he states in the last edition, published

in 1819, that the man was living, and in his usual health, in January of that year.*

I think it unnecessary to multiply cases of this affection, which is so common, and which must have occurred repeatedly to every medical practitioner who has taken the pains to make the necessary experiments for ascertaining it. My object in bringing forward the above two cases, has been to show that the albuminous matter present in the urine frequently more nearly resembles that found in the chyle than in the blood. In the first of these two cases, this fact, I presume, is too obvious to be doubted for a moment. Those who are disposed to question the second, will observe that the examination was made before my attention was particularly directed to this form of disease, and consequently before I had formed any general opinion on its nature.† I may also state,

* Dr. Wells, in the paper above quoted, has rendered it probable that in one case the urine was albuminous for a space of *nine* years.

† There are doubtless many who will consider this mode of establishing the point in question very unsatisfactory. To such I beg leave to observe, that, like many others of a similar nature, the present is a point that will not admit of *chemical demonstration* in the existing state of our knowledge; but must be established, if it be established at all, upon the evidence of the senses only. For instance, I know of no chemical tests that will enable us to distinguish the albuminous matter of chyle from that of the blood; but I have

generally, that since the first of the above cases occurred to me, I have examined many specimens of albuminous urine; and in most of these have thought that the albuminous matter present more resembled that of the chyle than of the blood. These cases have differed considerably in degree. In the slighter cases the usual principles of the urine, urea, lithic acid, &c.* have been commonly deficient in quantity; while the albuminous matter has seemed in no greater proportion than what might have been supposed necessary to form these principles, had the natural operation of the kidney taken place. In other cases, a larger proportion of albuminous matter has existed in the urine;

seen and examined both these fluids, and have observed that in their sensible properties, as well as in the appearances they exhibit when subjected to the action of different tests, they differ very considerably. These differences, however, are for the most part of such a nature, that they cannot be described so as to be rendered intelligible to another, but can be only known by *actual experience.* Under these circumstances, it is obvious that I can have no other grounds of the truth of the point in question to offer, than mere assertion, grounded on the evidence of the senses: and to give this assertion the greater probability, I have selected the above cases, in which the striking difference of the albuminous matter present, from that of the blood, and its near resemblance to that of the chyle, can hardly admit of dispute.

* Dr. Wells states that he never but in two instances saw a pink-coloured sediment in albuminous urine. The circumstance is rare, though it undoubtedly occasionally occurs.

but in no instance have I ever seen even an approach to the case first described.*

An albuminous condition of the urine appears to be capable of being excited by a variety of causes—as a long course of mercury, stimulating diuretics, violent passions of the mind, exposure to cold, &c. In many instances, however, I have not been able to trace it to any particular cause.

With respect to its tendency and danger, we have seen that slighter degrees of it, in which the kidney may be considered as simply *passive*, can exist for years, without apparently producing any serious effects upon the constitution. I believe, also, that this state of the urine frequently exists when it is not suspected; and that it may occasionally occur from some of the causes above-mentioned, even in the most healthy. The danger of the affection must of course increase with its permanency and degree; but it may be remarked that even in the extraordinary case above related the constitutional symptoms were by no means severe. I do not wish to

* I wish to be understood that I do not mean to assert that the albumen found in the urine is uniformly similar to that found in the chyle; but that, as far as I have observed at present, this is most generally the case; consequently that I do not presume to deny but the urine may be sometimes rendered albuminous by the serum of the blood. I may also observe, that, however well-founded or important the fact of the presence of chyle in the urine may be, I can not venture at present to draw any conclusion from it.

be understood to mean that it is not attended with danger. It is always undoubtedly an unpleasant symptom; and when permanent and excessive, must necessarily indicate some great derangement of the economy.

It remains for me, in the last place, to make a few remarks upon the general nature and mode of cure of this affection of the urine.

Dr. Blackall has attempted to show that when the urine is albuminous in dropsy, the use of blood-letting in general is indicated.* I confess that I have not had sufficient experience in albuminous dropsical urine to enable me to give a decided opinion on this point. I believe, however, that the presence of albumen in the urine is, in some instances, the first step towards the two conditions of the urine treated of in the next chapters; and we know that in the second of these, namely, diabetes, blood-letting occasionally has been practised with advantage: so far, therefore, the analogy appears in favour of Dr. B.'s opinion. On the other hand, from the irritable state of the system, and especially of the kidneys, which sometimes attends the separation of albuminous urine, the use of sedatives seems to be indicated. This also is pre-

* The notion that albuminous urine is "connected with too great action in some part of the system," seems to have originated with Dr. Wells; yet the remedy he chiefly recommends is the Tinct. Lyttæ. Ubi supra.

cisely analogous to what occurs in the diseases above-mentioned, where opium appears to be one of the most powerful remedies we possess. That opium is really beneficial in some cases where the urine is albuminous, I have no doubt: there may be cases also in which blood-letting may be useful; but whether the use of these remedies is equally admissible in all, as, for example, in dropsy, is not equally certain; and I believe very few would be inclined to recommend the use of opium, or even of blood-letting, in dropsy, upon the mere ground of the urine being albuminous. Upon the whole, then, not only from the above circumstances, but from many others that might be mentioned, I am induced to conclude that an albuminous condition of the urine, taken alone, as a *symptom*, does not, in the present state of our knowledge, indicate the use of any particular remedy or mode of treatment, but that, nevertheless, it is a symptom of which we ought to be always aware, since, taken in conjunction with the others, it may be occasionally useful in directing us to form a more correct judgment of the general nature of the disease.

CHAP. II.

Diseases in which an Excess of Urea is the Characteristic Symptom.

THE proportion of urea in healthy urine is such that, on the addition of nitric acid, no crystallization takes place till the urine is concentrated by evaporation. In a variety of cases, however, the quantity of this principle is so increased, that the above effect is produced without any concentration. This is always a mark of some derangement in the health, and occasionally appears to be characteristic of certain varieties of disease which have probably been frequently confounded with diabetes, and which it is my principal object to describe in the present chapter. Before, however, I proceed, I shall briefly notice some other forms of disease in which the proportion of urea is greater than natural, with the view of contrasting them with the disease in question, and thus of rendering the distinction more complete.

Whenever the specific gravity of the urine is high, for example, above 1·025 or 1·030, the proportion of urea, in common with the other principles, is necessarily larger than natural, and in this

case spontaneous crystallization will frequently take place on the addition of nitric acid. This concentrated state of the urine not unfrequently takes place in febrile and other diseases, and is quite unconnected with any disease of the urinary organs, and appears to depend upon a diminished secretion of water only. Hence, although this abundance of urea, as in all other cases, may be considered as indicating disease; yet in the present instance it is obviously no more so than the abundance of the other principles, and consequently leads to no particular plan of treatment, which must be regulated by the general nature of the disease.

In other instances an excess of urea, as compared with the other ingredients of the urine, is actually present. This happens, for example, not unfrequently in the urine of children and others depositing the phosphates. In such cases, however, more obvious and urgent symptoms are commonly likewise present. Hence the symptom of excess of urea, though important, cannot be considered as characteristic, and consequently should have little influence in directing our practice, which, as before, must be regulated by the more prominent symptoms.

Those diseases in which an excess of urea may be considered as in some degree characteristic, do not appear to have been hitherto distinguished,

but have been probably confounded with other diseases, and particularly with that form of diabetes which has been sometimes denominated diabetes *insipidus*. These diseases, however, differ considerably from diabetes, as the following observations will show.

The average specific gravity of the urine in these complaints seems to be a little above 1·020, and occasionally to vary from 1·015 to nearly 1·030. Most generally it is pale, but occasionally it is high coloured, and exhibits somewhat the appearance of porter, more or less diluted with water; and this variety in appearance not unfrequently takes place in the urine of the same person. When first voided, it reddens litmus paper. For the most part it is entirely free from sediment, except the mucous cloud of healthy urine; and the only remarkable property which it appears to possess is that of containing abundance of urea, so that on the addition of nitric acid, crystallization speedily takes place. From the quantity of urea present, it is very prone to decomposition, and soon becomes alkaline, especially in warm weather.

There is almost constantly in these diseases, a frequent and irresistible desire of passing water both by night and day. This desire is for the most part evidently excited by actual *diuresis*, or the increased quantity of urine; but frequently it

cannot be ascribed to this cause, as the quantity voided at one time is often by no means considerable; though in every instance that has fallen under my observation, the total quantity voided during any given time has appeared to be greater than natural. The quantity appears also to be particularly liable to be increased by cold weather, and by all causes producing mental agitation. There is sometimes a sense of weight or dull pain in the back; but this is by no means a constant symptom. There is also occasional irritation about the neck of the bladder, which sometimes extends along the urethra. The functions of the skin appear to be natural; at least in every case which has came under my own observation perspiration has been rather easily induced. The pulse is not affected. There is no remarkable thirst, nor craving for food, except in extreme cases, nor are the functions of the stomach and bowels much deranged: hence for the most part the tongue is clean, and the dejections regular and apparently natural.

In the few cases of this disease which have hitherto fallen under my own immediate observation, the subjects have been middle-aged men, of thin and spare habit, with a sort of hollow-eyed anxiety of expression in their countenance; free from gout and constitutional disease in general, and, as far as could be ascertained, from any organic

defect in the urinary organs. In every instance they had been induced to apply for medical advice not so much from the pain, as from the inconvenience, of the disease, and the dread of its ending in something worse: and, what may be worth remarking, in the majority of instances confessed that they had been addicted to masturbation from very early youth.

With respect to the causes of this affection, they are doubtless very various: whatever debilitates the system, and particularly the urinary organs, may give origin to it. Hence it may be induced by all those circumstances which give origin to albuminous urine, diabetes, and the deposition of the phosphates, with which diseases, as we shall find hereafter, it is most intimately connected.

I have had no opportunity of ascertaining the progress of these diseases; but think it extremely probable that, if permitted to proceed, some of them will terminate in diabetes, or in a deposition of the earthy phosphates. There seems, however, to be considerable variety in their symptoms as well as their nature; and I even think it probable that future observations will make us acquainted with many diseases having this symptom of abundance of urea, and those which generally accompany it in common, though differing altogether in their nature in other respects. This want of uniformity in the nature of the disease of course precludes the

idea of any uniform plan of treatment, which must be adapted to circumstances. In every case, however, which has hitherto fallen under my own observation or knowledge, sedatives, and particularly opium, have been the only efficient remedies; and by the judicious use of these, combined with other appropriate medicines, it is probable that in most instances the disease can be suspended, if not removed altogether. I select the following two cases, as illustrating more fully the preceding remarks.

The first case I shall relate, and which was indeed the one that originally drew my attention to this disease, was that of a gentleman about forty years of age, whose general appearance and constitutional habits coincided precisely with those above detailed. He had been subject to the complaint a considerable time, but latterly it had much increased, and he had now a very frequent desire to pass water, especially when under the influence of mental agitation, or when exposed to the cold air. The urine was generally of a brown porter colour, and not much more abundant than natural. The specific gravity of the specimen I examined was 1·0237. In this specimen the urea was most strikingly abundant, and there was also a little lateritious sediment. Occasionally he informed me that he passed urine of a very pale colour, and in this case it was more abundant, and was probably of much less specific gravity. He had no

thirst, and the functions of the skin appeared to be natural. He had lately, however, recovered from a slight feverish attack, and he felt occasionally some slight pain in the region of the liver; the tongue was also slightly furred, and the bowels rather irregular. From the presence of these latter symptoms I drew the conclusion that the affection in question was connected with some derangements of the functions of the liver, and of the general health, and accordingly ordered him mercury in alterative doses, with purgatives and the other means usually had recourse to on such occasions. About a month afterwards I saw him again. The urine was now free from sediment, and its specific gravity was reduced to 1·019; but it still exhibited the same brown colour, and the same great excess of urea, as before; and though his general health was evidently improved, the urinary complaint was in no degree diminished. He was now ordered a bitter infusion, containing potash and opium, and to keep his bowels regular by the occasional use of the alterative laxative pills previously prescribed. Under this plan the complaint sensibly became better in a few days; and in three weeks afterwards, when I saw him, was very considerably diminished. The urine was indeed of the same general appearance as before; but its colour was lighter, its specific gravity reduced to 1·0155, and the proportion of urea, though still excessive, was dimi-

nished. By persevering in this plan for some time, he became almost entirely free from the complaint, and continued so for some months, when it returned again in a slight degree. Similar means were again had recourse to, and it again yielded; since which time it has returned at intervals of some months (more frequently during the winter), but has always given way to the use of opium in very moderate doses, as, for example, Gutt. x. or xii. of the tinct. opii in a glass of soda-water once or twice a day. It is proper, however, to observe, that this gentleman's urine, though much improved, has never become quite natural, either in its appearance or in the proportion of the urea; and I think it probable that the disease will be occasionally liable to return for some time at least to come. I cannot, however, venture to give a decided opinion respecting its termination; though I think it not unlikely that, by perseverance in the above plan of treatment, it may ultimately be conquered.

The second case I shall relate, is one that occurred at St. Thomas's Hospital, to my friend Dr. Elliotson, who furnished me with the urine for examination every week, so as to enable me to ascertain the effects of the remedies employed.

March 6, 1819. —— Rodman, aged fifty-five. Symptoms resembling those of diabetes.—There is a constant craving for food.—Sensation of cold

over the body.—Frequent desire of voiding water, which in 24 hours amounts to sixteen pints.

The urine of this man was pale coloured. Its specific gravity was 1·020, and it contained a very large proportion of urea, but not the least particle of saccharine matter. On standing it also deposited crystals of lithic acid. Ordered *gr.* $1\frac{1}{2}$ *opii bis die.**

March 20.—Feels much better. Urine reduced to two pints in 24 hours. *Pergat.*

The urine was now somewhat deeper coloured, and deposited a copious sediment consisting partly of lithic crystals and partly of lateritious sediment. Its specific gravity was increased to 1·0344, evidently from its having become more concentrated than natural. The quantity of urea was abundant, but not in the proportion in which the urine was concentrated.

This man became so well shortly after the above date, that he did not return again to the hospital till

August 19.—Disease returned six weeks ago.—Feels as ill as ever.—Very weak.—Bowels costive.—Quantity of urine in 24 hours about four pints. Ordered *opium as before.*

The urine now was transparent. Its specific gravity was 1·0231, and urea was abundant.

* Opium was ordered in this case by Dr. E. on the supposition that the disease was diabetes.

Under the above plan he again speedily became better, and soon afterwards ceased to attend at the hospital, and has not since been heard of.*

These two cases may be considered as exhibiting the extremes of the class of diseases under consideration. Between these two extremes several intermediate grades of the disease have occurred to me; sometimes variously complicated with different complaints, which required other treatment. In all these, as before observed, sedatives (either opium or hyosciamus) have formed the chief part of the plan of cure, and have uniformly been more or less beneficial. I did, indeed, chiefly by way of experiment, order copaiba in one instance, but found it decidedly increase the complaint, which I apprehend will be found to be the case with all stimulating remedies.

I may observe, in conclusion, that I was induced to have recourse to opium in this complaint, from knowing its good effects in diabetes under the circumstances to be explained in the next chapter.

* Since the above was written, and so lately as September of the present year, this man returned again to the hospital, on account of another, and very different disease. The specific gravity of the urine was now 1·0282. It abounded in lithic acid, *but contained no excess of urea*, and he had been quite free from his former complaint for upwards of twelve months.

CHAP. III.

Diabetes.

THE term *diabetes*, implying simply an increased flow of urine, is doubtless applicable to any disease in which that symptom is present in a remarkable degree. A great deal of confusion, however, has arisen from this general use of the term; as a variety of diseases, differing altogether in their nature, except in the accidental circumstance of being accompanied by *diuresis*, or a large flow of urine, have been confounded with one another. Some of these diseases have been of a temporary nature, as various nervous affections, local irritation about the bladder or urethra, &c. Others have been of a more permanent description—such, for example, as the diseases described in the last two chapters. To prevent this confusion in future, I would recommend that the term be restricted to those affections in which the urine is *saccharine*. Hence, I would define diabetes to be a disease in which a saccharine state of the urine is the characteristic symptom.

The urine of diabetes is almost always of a pale straw colour. Its smell is commonly faint and pe-

culiar, sometimes resembling sweet whey or milk. Its taste is always decidedly saccharine in a greater or less degree. Its specific gravity has been stated to vary from 1·020 to 1·050. I have seen it higher than this, but never so low. The quantity of urea is almost always very much diminished, though I have never met with a specimen in which it was entirely absent. It contains, for the most part, little or no lithic acid. The usual saline matters existing in healthy urine are met with in diabetic urine in nearly the same relative proportions, but their absolute quantity is very much diminished. Sometimes diabetic urine contains a little blood;* and not unfrequently albuminous matter analogous to that of the chyle. I have seen it also contain a white milky-like fluid precisely similar to chyle, which slowly subsided to the bottom of the vessel. In this case the vinous fermentative process was induced very rapidly in the urine, the chylous matter apparently acting like yeast.

The following table, constructed by Dr. Henry, shows the quantity of solid extract in a wine pint of urine of different specific gravities, from 1·020 to 1·050. In the experiments which furnished the data of this table, the urine was evaporated by a steam heat till it ceased to lose weight, and till it left an extract which became solid on cooling.†

* See Watt's Cases of Diabetes, p. 47, 74.

† See Annals of Philosophy, i. p. 27.

Specific gravity compared with 1000 parts of water at 60°.	Quantity of solid extract in a wine pint.	Quantity of solid extract in a wine pint, in			
	grains.	*oz.*	*dr.*	*scr.*	*grs.*
1020	382·4	0	6	1	2
1021	401·6	0	6	2	1
1022	420·8	0	7	0	0
1023	440·0	0	7	1	0
1024	459·2	0	7	1	19
1025	478·4	0	7	2	18
1026	497·6	1	0	0	17
1027	516·8	1	0	1	16
1028	536·0	1	0	2	16
1029	555·2	1	1	0	15
1030	574·4	1	1	1	14
1031	593·6	1	1	2	13
1032	612·8	1	2	0	12
1033	632·0	1	2	1	12
1034	651·2	1	2	2	11
1035	670·4	1	3	0	10
1036	689·6	1	3	1	9
1037	708·8	1	3	2	8
1038	728·0	1	4	0	8
1039	747·2	1	4	1	7
1040	766·4	1	4	2	6
1041	785·6	1	5	0	5
1042	804·8	1	5	1	4
1043	824·0	1	5	2	3
1044	843·2	1	6	0	3
1045	862·4	1	6	1	2
1046	881·6	1	6	2	1
1047	900·8	1	7	0	0
1048	920·0	1	7	1	0
1049	939·2	1	7	1	19
1050	958·4	1	7	2	18

This table enables us to ascertain with considerable precision the quantity of solid matter voided by a diabetic patient in a given time. Thus, suppose ten pints are passed in 24 hours, of the average specific gravity 1·040, it is evident that

this will contain $\overline{10 \times 1 .. 4 .. 2 .. 6} = 15 .. 7 .. 2$, or upwards of a pound and a quarter of solid extract!

Diabetes is always accompanied by more or less of *diuresis,* and sometimes the quantity of urine voided is enormous. Thus, cases are on record in which 30 pints have been discharged every 24 hours, for weeks or even months together. In such cases the quantity of urine voided has been said to be more than double the whole ingesta—a circumstance which physiologists have puzzled themselves a good deal to explain. I believe, however, that in the best authenticated cases this enormous difference between the quantity of ingesta and urine has not been observed.*

The constitutional and other affections usually accompanying a saccharine state of the urine are summarily enumerated by Mr. Watt as follows:

"The appetite is usually better than in health. Uneasiness in the stomach after meals; thirst urgent; the mouth dry and parched; tongue white and foul, sometimes unnaturally clean and red; tough disagreeable mucus in the throat; depraved taste; skin dry and unperspirable; considerable emaciation; weariness, and aversion to exercise; loss of strength; pain and weakness in the region of the kidneys; irregular, generally costive state

* See Watt on Diabetes, p. 158.

of bowels; some degree of inflammation and uneasiness about the external orifice of the urethra; loss of virility; chilly state of body; cold feet; a tendency to œdema; heat and uneasiness in stomach and bowels; acid eructations; flatulence; eyes muddy and painful; indistinct vision; vertigo; head-ach; dyspnœa on the least exertion; gums spongy and ulcerated; weight about the præcordia; a tendency to sigh; listlessness; mind weak and peevish; spirits greatly exhausted." * Pulse variable, but generally marking debility.

Such is the dreadful catalogue of evils which more or less harass the unfortunate victims of this formidable disease. As it proceeds, the debility increases, and some pulmonic symptoms, accompanied by hectic fever, generally make their appearance, which sooner or later prove fatal. Occasionally it terminates in incurable dropsy, and sometimes the patient is cut off suddenly.

In endeavouring to explain the affections accompanying diabetes, we must consider the disease in a two-fold light—first, as a simple saccharine condition of the urine, without any regard to its quantity; and, secondly, as a similar condition of

* On Diabetes, p. 196.

the urine, accompanied at the same time by more or less of *diuresis*.

With respect to the first of the above forms of the disease, no one seems to have hitherto distinctly described it. Its existence, therefore, at least as an original form of disease, must, in the present state of our knowledge, be considered as somewhat hypothetical. There can be little doubt, however, that such a form of diabetes actually does exist, for example, in its incipient stages; while the symptoms attending it, which are probably slight, have been overlooked, or if more severe, have been referred to other causes.

The first symptom which usually attracts the patient's attention, as well as that of the physician, in this disease, is the increased flow of urine. Whether this be a consequence of the simple *saccharine* condition of the urine, or whether it depend upon other causes, is unknown.* However this may be, the *quantity* of the urine seems in some degree to be a measure of the severity of the disease; for the greater the flow of urine, the greater, for the most part, the specific gra-

* The most probable cause of the increased flow of urine is that irritable state of the system which forms a part of the disease, and which appears to resemble nearly that peculiar condition sometimes present in hysteria and other nervous affections, in which a large flow of limpid urine frequently takes place.

vity and proportion of sugar which it contains, and the more severe the patient's sufferings. In this form of the disease, an enormous drainage from the system evidently takes place of what must be considered as essential to its preservation and health: and it is probably to this enormous drainage, and not to the mere saccharine condition of the urine, that a great many of the most distressing symptoms usually occurring in diabetes are to be referred. "The loss of so much matter," says Dr. Elliotson very justly, "from the system, sufficiently explains the hunger, the feeling of emptiness and sinking in the stomach, the emaciation, debility, anaphrodisia, coldness of the legs, pains both of them and of the loins, the depression of spirits, &c. without attributing the disease to the stomach or the kidneys exclusively. The excessive escape of fluid, or, when this does not take place, the feverishness, equally explains the thirst and dryness of the skin." *

With respect to the immediate cause and nature of diabetes, a variety of opinions have been entertained by different physiologists; some maintaining it to be an affection of the kidneys, others of the stomach and digestive organs; others, again, considering it as closely allied to dropsy. That the functions of the kidney are deranged, there can be

* Numerous Cases illustrative of the Efficacy of Hydrocyanic or Prussic Acid in Affections of the Stomach, &c. p. 90.

no doubt; but beyond this I believe we know nothing that is certain; at least I do not.

Equally various opinions have been maintained with respect to its remote or exciting cause. Thus it has been ascribed to intemperance, and especially the immoderate use of spirits; to severe evacuations, to excessive labour joined with a poor and acescent diet, to exposure to cold, &c. From analogy I think it not improbable that it may take place from some injury of the spine; though I confess I have never known it arise from this cause.

With respect to the prognosis in this disease, it is always extremely unfavourable.

The remedies recommended in diabetes have been as various as the opinions respecting its nature; even to enumerate them all, would be loss of time. Those whose effects have been best ascertained, and which seem most entitled to our attention, are animal diet, blood-letting, and opium.

I stated above, that, in a practical point of view, diabetes may be considered in a two-fold light: as a simple saccharine condition of the urine, without an increase in its quantity; and, as complicated with a preternatural flow of that secretion. This distinction is of the utmost importance with reference to the operation of remedies in this affection, all of which have been designed to act, and probably do act primarily, by diminishing the flow

of urine, before they induce any favourable change in its quality. Want of attention to this simple distinction has doubtless caused great confusion in the history of this disease; and substances, in consequence, have been extolled as remedies, which have acted simply by diminishing the flow of urine and its consequences, without altering in the least degree its saccharine condition.

It seems to be generally admitted that animal diet has a tendency to diminish the quantity of urine; but whether it really improves its quality, we are not at present enabled to state. It has been said, indeed, to render the urine less saccharine to the taste; but this test is very deceptive; and no experiments have been made, as far as I know, with the view of ascertaining its effect upon the specific gravity, which is the only certain criterion. The next remedy, blood-letting, stands in precisely the same predicament. That it has diminished the quantity of urine, there can be little doubt; but the evidence is by no means so clear that it has improved its quality. I think, however, that there are stronger grounds for presuming that blood-letting has improved the quality of the urine, than that animal diet has produced this change.

The effects of opium in diabetes have been more clearly and satisfactorily ascertained than those of any other remedy. Within the last three years I have had an opportunity of examining at short

intervals the urine of three diabetic patients while under a course of opium. These cases occurred to my friend Dr. Elliotson, at St. Thomas's Hospital, and have been lately published by him; * but as they perhaps constitute the most precise data we possess, I think it proper to give a summary account of them here.

After premising a short historical account of the use of opium in this disease, in which he shows that it is not a new remedy, Dr. E. proceeds to relate the cases in question, of which the following are abstracts.

Case 1. April 2, 1818.—John Beck, a baker, 51 years of age, afflicted with diabetes upwards of four years, which he attributed to wheeling *a very heavy truck.* Has been under the care of several practitioners; been two or three times bled to a small amount; taken alum, &c. and had blisters applied to the loins, without benefit. Has made as much as 16 or 20 pints of urine in a day; but now makes only about 8 or 10 pints, the specific gravity of which is 1·0448. Has all the usual symptoms of diabetes in an eminent degree.—Ordered *pulv. ipecac. c. gr. x. b. d. the dose to be gradually augmented to ℈ ii.*

Under this plan his urine decreased in quantity, and became less sweet, and his skin acquired soft-

* Op. cit. p. 89.

ness and moisture; but as he improved slowly, bleeding was directed; and on the 25th June he lost 25 ounces, the next Saturday 30 ounces, the next 30 ounces, and the next 25 ounces, without any ill or decided good effect.

A purging now took place. Ordered *pulv. kino c. ʒ ss. with gr. ii. at first, and then gr. iii. opii t. d.*

After this the urine decreased to five or six pints, and became bitter; he felt improved, and the diarrhœa ceased. He now became stationary, and on September 5th was again bled to 20 ounces, which was repeated on the following week to 25 ounces. The last time he fainted from the loss of blood, and was in all respects worse. Urine increased to seven pints. Ordered *bark, camphor mixture, &c.*

While taking the bark, &c. he was attacked with jaundice, and the œdema, under which he had laboured for some time, extended to his hips. Ordered *cal. gr. iv. opii gr. ii. b. d. with tinct. ferri ammoniat. gutt. L. t. d.*

The dose of opium was increased to gr. vii. that of the cal. to gr. iv. and of the tinct. ferri ammoniat. to gutt. c. The œdema entirely disappeared, the urine decreased to four pints and a half, and he became in most points better. His mouth was slightly affected.

Dec. 23.—The calomel was omitted. Ordered *opii gr. viii. b. d. and tinct. ferri ammoniat. gutt.*

cxxx. t. d. Urine pale coloured, and of specific gravity 1·0418.

January 16, 1819.—Ordered *opii gr. ix. b. d.* He had now very little thirst or craving for food, and was much stronger. Urine five pints daily, and of specific gravity 1·0308.

January 30.—He was almost free from every symptom. The urine contained no sugar, was quite of its natural composition, and its *specific gravity had descended to* 1·0148.

He now, by mistake, took, instead of the opium, gr. xlv. of the pil. hydrarg. twice a day for four days. This nearly cost him his life, by bringing on a severe ptyalism and purging; and from 1·0148 the specific gravity of the urine suddenly mounted up to 1·0555: but whether the quantity was increased, could not be ascertained, on account of the diarrhœa. Ordered *opii puri gr. ix. b. d.*

The subsequent part of the report is given by Dr. E. in a tabular form, from which I shall only abstract the most prominent particulars.

The dose of opium was gradually increased; and on April 24, had reached gr. xviii ss. b. d. During this time he had continued upon the whole to get better, and the urine had become less in quantity. Another unlucky mistake now occurred, which again threw him back considerably gr. iv. opii having been taken by him instead of

gr. xx. Under the use of this diminished dose he became much worse in all respects, and the pain he suffered was intense.

April 29.—Ordered *opii* ℈ *i. bis die.*

May 8.—Much better; feels strong and well; can walk ten miles a day. Urine 4½ pints; urinous smell, and contains even more urea than natural.

After this time he was sometimes better, sometimes worse; and his amendment, upon the whole, was inconsiderable. The dose of the opium during this time was gradually raised; and on Dec. 11, had reached gr. xlv. t. d. The quantity of the urine varied from four to six pints, and its specific gravity from 1·040 to 1·050; and it always contained a large proportion of sugar, more or less of urea, and occasionally deposited lithic acid.

From Dec. 11 to July, 1820, the dose of the opium was gradually diminished, with the hope of keeping him stationary with a smaller dose. On July 1, it was reduced to gr. xxx. t. d.; and at this time Dr. E. concludes by observing that he "had remained for many months nearly in the same state. The opium had not lessened the complaint, but certainly had kept it stationary. His health was not at all worse, but indisputably better than it was when he first applied for advice two years and a quarter ago. This is saying very much; for his constitutional symptoms were intense

at his admission. He then, besides, made eight or ten pints of water per diem; now he makes only six."

Case 2. January 20, 1820.—Edward Cox, aged 24. "Had been diabetic three months, without any assignable cause. Was short, and apparently a poor creature both in body and mind at all times. Was making 20 pints of sweet urine per day; was weak and emaciated, and always hungry, thirsty, and cold, especially in the legs and feet. As he had pneumonic symptoms, *venesection ad* ℥x. was ordered."

The specific gravity of the urine, before bleeding, was 1·0371, and five minutes afterwards 1·0402. It became turbid on evaporation, but not from containing albumen, and it yielded a large proportion of very pure white sugar. Traces of urea were evident; and when evaporated, it afforded a milky smell. A course of opium was fixed upon; but being in a work-house, he could not always get out, and therefore attended irregularly. Dr. E. then presents us with a tabular view of the treatment and results, from which he concludes—

"The effect of opium was equally striking here. The quantity was at first in a few days lessened several pints; and not only on three occasions of the omission of the opium instantly increased, but, upon the resumption of the medicine, as regularly lessened again. When he first applied to me, he was making twenty pints; at the last visit

(June 10), only four or five. Notwithstanding this, the specific gravity of the urine has continued high (about the same as at the beginning). No lithic acid has ever appeared in it; nor has it been materially changed in any of its qualities.*

Case 3. "May 11, 1820.—William Cochlan, aged 55, extremely feeble and emaciated. Had laboured under diabetes seven months, with all the usual symptoms. He at first made 14 pints of sweet urine daily; but they were reduced to six pints in Guy's Hospital, by persisting in the use of animal diet and pul. ipecac. c. for thirteen weeks. The medicine alone has been continued during the last seven weeks since he left the hospital. Has made but three or four pints of urine a day for the last fortnight. At present is afflicted with diarrhœa. Specific gravity of the urine 1·0376. Ordered *gr. ii. opii. t. d. dein gr. iii. t. d.*"

The dose of opium remained at gr. iii. t. d. till July 8, when the account of the case closes. On this case, which must be acknowledged to be imperfect, Dr. E. remarks—"The effect of opium has already been observable in him. His great improvement while in Guy's Hospital is at least as referable to the animal diet as to the opium; but its stationary state, after he relinquished the diet, was probably owing to the continuance of the pul. ipecac. c. On my giving him larger doses of opium than were contained in his doses of that compound, the quantity of his urine per day diminished a

pint, and he felt so much better, as actually to go to work at his trade of a cooper. The diarrhœa not only reduced him, but occasioned his absence from the hospital; and when he was seen afterwards it was not on a regular day, and he was ordered merely a decoction of logwood. The opium shall now have a full trial. Its resumption has already caused the appearance of lithic acid."*

The powers of opium in diminishing the quantity of urine, and its consequences, are placed, by these cases, in a striking point of view. In each of them the quantity at first was far above the natural standard, and in each was the quantity reduced to nearly the healthy state, by the undoubted powers of this remedy. The sufferings of the patients were consequently very much diminished, and existence, at least that of Beck, was evidently prolonged.

With respect to the second and, perhaps, most important point, namely, how far opium has the power of improving the quality of the urine, there is greater room to doubt. Before the unfortunate mistake with the mercury, Beck's urine was certainly rendered quite natural, both in its specific gravity and composition; but after this no material improvement appears to have taken place even up to the present time; though by per-

* This poor man ceased to attend at the hospital, and died shortly afterwards; but under what circumstances is unknown.

severance this may yet be effected, as his health is quite as good, if not better, than it was when he first came under Dr. E.'s care. Although, however, we have no very satisfactory evidence of the power of opium in completely restoring the natural state of the urine, yet we have abundant proofs of its power in effecting changes in it which appear to be of a curative nature. On looking over the tabular view presented by Dr. E. we find that the first immediate effect of opium upon the urine is to increase its specific gravity. This is what might have been expected from this remedy, and evidently depends upon the diminished secretion of water, while that of the sugar remains unaltered, by which the urine is of course rendered more concentrated, and consequently heavier. As the remedy is persevered in, the urine acquires its original specific gravity, and even becomes lighter. The quantity of sugar is diminished, and that of urea much increased, even sometimes so as to become greater than natural. Lithic acid makes its appearance often in abundance—a substance which has been denied to exist in diabetic urine; and the urine acquires altogether a more natural colour and appearance, and is rendered much less prone to undergo the vinous fermentation.

In conclusion, it may be stated, with respect to the three remedies, animal diet, blood-letting, and opium, that they probably do not interfere with each other: hence, as observed by Dr. Elliotson,

they may perhaps be had recourse to conjointly. This plan at least deserves a careful trial, as we are acquainted at present with no set of remedies for this formidable disease from which we are entitled to expect so much advantage.

On taking a review of the three preceding chapters, we are naturally struck with the obvious analogy that prevails among the diseases treated of. The operations of the kidneys are indeed specifically different in each; being in the first apparently suspended only, in the second inordinately increased, and in the third depraved: but notwithstanding this, the three diseases are more or less accompanied by a similar increased flow of urine and its consequences, and probably gradually run, in some instances, into one another. Hence the symptoms in all are of the same general character, and differ little from one another except in degree. Thus there is the same *hysteric* irritability of the system (if I may be allowed the expression), the same hurried action of the kidney, and pallor urinæ in all; and when the diseases are extreme, the same unnatural craving for food, and other symptoms denoting an extraordinary drainage from the system. The exciting causes are probably of the same general character, and the prognosis upon the whole unfavourable in each:

that is to say, the chance of *a permanent cure* is doubtful; though in this respect diabetes obviously far exceeds the others. Lastly, the general principles of cure in each closely resemble one another.

But these are not the only diseases to be referred to the present class: the deposition of the earthy phosphates obviously belongs, as we shall find hereafter, to the same class. It will be seen, however, that I have adopted a plan of arrangement by which this affection is separated from those we have just considered. But I wish to be understood that this has not been done from choice or ignorance, but merely for the sake of the convenience of bringing under one point of view all those diseases which are liable to produce a secondary or mechanical effect, however much they may differ from one another in their nature. In doing this I have indeed followed the usual method of arrangement; but am aware of its imperfections; and that a strict nosological arrangement, founded upon natural principles, requires that all those diseases which are similar in their nature, should be classed together, without any reference to their *mechanical* effects. But the medical art is too imperfect at present for such an arrangement; and we must be content, I fear, for ages yet to come, with something less perfect.

SECTION II.

ON THE DISEASES OF THE URINE IN WHICH PRINCIPLES INSOLUBLE IN THAT SECRETION ARE MORBIDLY DERANGED IN QUANTITY OR QUALITY.

CHAP. I.

Description of Urinary Gravel and Calculi, with a summary Account of their Chemical Composition, &c.

MECHANICAL deposites from the urine, though composed of the same general ingredients, may, in a pathological point of view, be conveniently divided into three classes—1. Pulverulent, or amorphous sediments; 2. Crystalline sediments, usually denominated gravel; and, 3. Solid concretions, or calculi formed by the aggregation of these sediments.

I. *Pulverulent or amorphous sediments.* These sediments almost universally exist in a state of solution in the urine before it is discharged, and even afterwards till it begins to cool, when they are deposited in the state of a fine powder, the particles of which do not appear to be crystalline.

Their general appearance is very various, though their colour, for the most part, is red, diluted with more or less of brown or yellow. Their composition is as various as their colour; and they may be said to contain, at different times, almost every principle capable of becoming solid itself, or of forming a solid compound with any other principle found in the urine. Generally speaking, however, they may be stated to consist of two species of neutral saline compounds, viz. the lithates of ammonia, soda, and lime, tinged more or less with the colouring principle of the urine, and with the purpurates of the same bases, and constituting what are usually denominated *pink* and *lateritious* sediments; and, secondly, the earthy phosphates, namely, the phosphate of lime, and the triple phosphate of magnesia and ammonia, constituting for the most part sediments nearly white. These two species of sediments very frequently occur mixed together, though the lithates generally prevail; and it is to this circumstance, and to the little tendency that the salts of which they are composed have to assume the crystalline form, that their heterogeneous and amorphous nature is to be referred.

II. *Crystalline sediments, or gravel.* This class of sediments is commonly voided in the form of minute angular grains, or crystals mechanically

diffused through the urine, and which subside almost immediately to the bottom of the vessel in which it is contained. In such cases, which may be considered of an extreme kind, an additional quantity of crystals is usually deposited as the urine cools. In slighter cases, few or perhaps no crystals are voided with the urine; but they are deposited abundantly upon its surface, and upon the sides of the vessel in which it has stood for some hours. These crystals are composed of—1. Lithic acid nearly pure;* 2. The triple phosphate of magnesia and ammonia; and, 3. Oxalate of lime.

The crystals of lithic acid, which are by far the most frequent, are always more or less of a red colour. Those composed of the triple phosphate of magnesia and ammonia, are always white; while those composed of the oxalate of lime, which are extremely rare, are of a dark blackish green colour.

It may be remarked, that these different va-

* I have said *nearly pure*, because they always contain colouring matter, &c. Berzelius, indeed, states that they consist of the *super-lithate* of ammonia; and it is true that they not unfrequently give off a little ammonia when dissolved in a solution of potash: but whether the ammonia be in actual combination with the lithic acid, or whether it be derived from a small proportion of the common lithate or purpurate of ammonia, with which they may be contaminated, I have been unable to ascertain. I incline at present to the latter opinion.

rieties of crystalline deposites are never voided together in the same urine, though they not unfrequently occur with amorphous sediments.

The nature of these sediments may be ascertained by the means to be presently pointed out under the head of calculi composed of similar substances.

III. *Solid concretions, or urinary calculi.* From various causes, to be explained hereafter, the before-mentioned sediments concrete together in solid masses, forming what are well known under the name of urinary calculi. The various appearances and chemical properties of these calculi have been so ably and completely described by Dr. Marcet, in his recent publication,* that I do not think it necessary to enter upon the subject here further than is absolutely requisite for the completion of my object. The following are the species of calculi already known.

1. *The lithic acid calculus* is generally of a brownish red or fawn colour, but occasionally of a colour approaching to that of mahogany. Its surface is commonly smooth, but sometimes finely tuberculated; and upon being cut through, it is generally found to consist of concentric laminæ. Its fracture generally exhibits an imperfectly crys-

* An Essay on the Chemical History and Medical Treatment of Calculous Disorders. By Alexander Marcet, M.D. F.R.S. &c.

talline texture, sometimes an amorphous or earthy one, in which case it usually contains a mixture of other substances. This is one of the most common species of calculi.—*Chemical characters.* Before the blow-pipe this calculus blackens, emits a smoke having a peculiar odour, and is gradually consumed, leaving a minute quantity of white ash, which is generally alkaline. It is completely soluble in caustic potash, and precipitable again by any acid in the form of a white granular powder. Lastly, if to a small particle a drop of nitric acid be added, and heat applied; the lithic acid dissolves; and if the solution be evaporated to dryness, the residue assumes a beautiful pink or carmine colour.

2. *The lithate of ammonia calculus* is generally of a clay colour. Its surface is sometimes smooth, sometimes tuberculated. It is composed of concentric layers, and its fracture is very fine earthy, resembling that of compact lime-stone. This calculus is generally of small size, and rather uncommon: but the lithate of ammonia very frequently occurs mixed with lithic acid, forming a mixed variety of calculus.—*Chemical characters.* This in many of its properties closely resembles the last species. Before the blow-pipe, however, it usually decrepitates strongly. It is much more soluble in water than the lithic acid calculus; and always gives off a strong smell of ammonia on being heated

with caustic potash. The lithate of ammonia is also readily soluble in the alkaline sub-carbonates, which pure lithic acid is not: and in this case the fixed alkali seems to take the place of the ammonia, while the ammonia combines with the carbonic acid of the sub-carbonate.*

3. *The oxalate of lime, or mulberry calculus,* is generally of a very dark brown colour, approaching to black. Its surface is very rough and tuberculated (hence the epithet of *mulberry*). It is usually hard, and when cut through exhibits an imperfectly laminated texture. This species of calculus seldom surpasses the medium size, and is rather common. There is a variety of it remark-

* Perhaps this fact will enable us to account for the effect said to be produced by alkaline carbonates upon calculi in the bladder, when long persevered in. This opinion is also rendered further probable, by another fact which I have several times noticed where alkaline remedies have been long taken, and where probably amorphous sediments abounded in the urine—namely, that a large proportion of the external white crust of the calculus, which has been supposed in general to consist of the phosphates, has consisted of the lithate of soda or potash (according as the alkaline matter taken has been soda or potash) mixed with a small relative proportion of the phosphates. A similar change also sometimes takes place in the composition of amorphous sediments themselves, from the exhibition of the same remedies. In such cases the change is evidently for the worse, as the lithates of soda and potash are less soluble than the lithate of ammonia.

ably smooth, and pale coloured. These are always of small size; and, from their colour and general appearance, have been termed the *hemp-seed* calculus.—*Chemical characters.* Before the blowpipe this species of calculus expands into a kind of white efflorescence, which, when moistened and brought into contact with turmeric paper, stains it red. This white alkaline substance is the caustic lime deprived of its oxalic acid.

4. *The cystic oxide calculus* is of a yellowish white colour, and its surface, which is commonly smooth, exhibits a kind of crystalline appearance. When broken, it is found not to consist of distinct laminæ, but appears as one mass confusedly crystallized throughout its substance. The fracture exhibits a peculiar glistening lustre like that of a body having a high refractive density; and when in small fragments, it is semi-transparent. This calculus is small, or not surpassing the medium size, and is very rare.—*Chemical characters.* This yields a very peculiar and characteristic odour when exposed to the flame of a blow-pipe. It is also very readily soluble both in acids and alkalies.

5. *The bone earth, or phosphate of lime calculus,* is generally of a pale brown colour; and its surface is so smooth, as to appear polished. When sawn through, it is found very regularly laminated, and the laminæ readily separate from one

another. These laminæ are striated in a direction perpendicular to the surface, as from an assemblage of fibres. This species of calculus has not hitherto been observed of large or even of medium size, and is extremely rare.—*Chemical characters.* This does not fuse before the heat of the blow-pipe. It is readily soluble in muriatic acid, and precipitable in the form of a white powder without decomposition.

6. *The triple phosphate of magnesia and ammonia calculus* is always nearly white; its surface is commonly uneven, and covered with minute shining crystals. Its texture is not laminated, and it is easily broken and reduced to powder. In some rare instances, however, it is hard and compact, and when broken, exhibits a crystalline texture, and is more or less transparent. Calculi composed entirely of the triple phosphate of magnesia and ammonia are rare; but specimens in which this constitutes the predominant ingredient are by no means uncommon.—*Chemical characters.* Before the heat of the blow-pipe, this calculus gives off the odour of ammonia, and at length melts with difficulty. It also gives off ammonia when treated with caustic potash. It is much more soluble than the preceding species in dilute acids, from which it is again readily precipitated by ammonia in its original crystalline form.

7. *The calculus composed of a mixture of the phosphate of lime and triple phosphate of magnesia and ammonia, or the fusible calculus*, is commonly whiter and more friable than any other species, resembling sometimes a mass of chalk, and leaving a white dust on the fingers. This species is generally not laminated. Occasionally, however, it separates readily into laminæ, the interstices of which are often studded with sparkling crystals of the triple phosphate. The variety of this species which is not laminated often acquires a very large size, and assumes the form of a spongy friable whitish mass, evidently moulded to the contracted cavity of the bladder in which it has been formed. This species of calculus occurs very frequently.—*Chemical characters*. It may be readily distinguished by the ease with which it melts before the blow-pipe. It also dissolves readily in acids, and particularly in dilute muriatic acid; and if to the solution oxalate of ammonia be added, the lime is precipitated alone, and the magnesia may be afterwards separated by the addition of pure ammonia.

8. *The alternating calculus*, as the name imports, may consist of different layers of any of the preceding species. Hence its general appearance, texture, &c. will depend entirely on the composition, and may be very varied. Most commonly

it is composed of a lithic acid or mulberry nucleus, and an external crust of the fusible calculus. In some rare instances it is composed of laminæ of all three of these substances, and sometimes of even more—the mixed phosphates still continuing to constitute the external crust. This species of calculus often acquires a very large size, and is very common.—*Chemical characters.* The chemical characters must of course vary with the composition; and as the different substances of which it is composed must almost certainly be some of the preceding, the nature of the different laminæ can be readily ascertained by what has been already stated.

9. *Mixed calculi* consist of an intimate mixture of any two or more of the preceding species; but generally of a mixture of the lithate of ammonia and the phosphates.* Their colour of course varies with their composition; but is commonly indeterminate. They are for the most part not laminated, and possess considerable hardness. They have been seldom seen of large size, and fortunately are very rare.—The *chemical characters* of mixed calculi of course are of an ambiguous nature, and will depend upon their composition. The nature of the different principles entering into their composition

* There is obviously a strong chemical objection to the opinion that uncombined lithic acid and the phosphates can be precipitated from the urine at the same time.

may be readily ascertained from what has been already stated.

10. *Carbonate of lime calculus.* I have seen some small calculi composed almost entirely of this salt. They were perfectly white, and very friable. Mr. Smith has described others which closely resembled in appearance the mulberry calculus.* This species of calculus is very uncommon. As to their chemical characters, they are readily detected by their dissolving with effervescence in acids, and other well-known properties.

To these ten species Dr. Marcet has added two others, namely,

11. *The xanthic oxide calculus,* of which only one specimen seems yet to have been observed; and,

12. *The fibrinous calculus,* apparently composed of the fibrin of the blood. Both these calculi were small, and are probably of very rare occurrence. The former was termed *xanthic* or *yellow oxide,* from its characteristic property of yielding a yellow colour when acted on by nitric acid. The latter was found to possess all the characters of the fibrin of the blood.

There is another species of calculus which, though not of urinary origin, is very liable to be mistaken for such, from the situation in which it is formed —namely,

* Med. Chirurg. Trans. xi. p. 14.

13. *The prostate calculus.* This is formed in the prostate gland. Its colour is yellowish brown. It is small, and more or less rounded in shape, and consists of neutral phosphate of lime tinged by the secretion of the prostate gland. By these properties calculi formed in the prostate gland can always be readily distinguished from calculi derived from the urine.

CHAP. II.

Data showing the Comparative Prevalency of the different Forms of Urinary Deposite, and the Order of their Succession. Observations founded upon these Data, illustrative of their General Pathology, &c.

IN treating of this part of my subject, as well as others of a similar nature, I shall avail myself of the data which have been published by preceding authors; and in doing this, shall, in the first place, lay before my readers the different data, in the order of time in which they have been published.

The first collection of calculi, of which an examination was made, adapted to my present purpose, was that in the Hunterian Museum. The examination was made by Mr. Brande. According to this gentleman, of 150 calculi, the following were the relative proportions of each species:

Of lithic acid, nearly pure	16	61
Of lithic acid mixed with a small relative proportion of the phosphates	45	
Of oxalate of lime, chiefly		6
Of the phosphates, nearly pure	12	78
Of the phosphates mixed with a small relative proportion of lithic acid	66	
Of lithic acid and the phosphates with nuclei of oxalate of lime		5
		150*

* Philos. Trans. xcviii. p. 226.

The next tables I shall quote are from Dr. Marcet's work. Of 181 specimens taken by that gentleman, indiscriminately, from the extensive collection at Norwich, the following are stated to be the relative proportions of each:

Of lithic acid, in which the character was well defined,			66
Of oxalate of lime chiefly			41
Of the phosphate of lime, nearly pure		4	53
Of the phosphate of lime and triple phosphate, constituting the fusible calculi		49	
Alternating calculi composed of	Lithic and mulberry	15	19
	Mulberry and triple	1	
	Fusible and lithic	1	
	Fusible and mulberry	2	
Compound or mixed calculi			2
			181*

In the collection at Guy's Hospital, consisting of 87, the following are the relative proportions according to the same gentleman:

Of lithic acid, nearly pure	16	22
Of lithic acid mixed with a little oxalate of lime	6	
Of oxalate of lime		22
Cystic oxide		1
Of the phosphate of lime, nearly pure	3	29
Of the triple phosphates	2	
Of the mixed phosphates or fusible calculi	24	
Alternating calculi		6
Compound calculi		7
		87†

Of 187 calculi, constituting the aggregate of the different collections of various gentlemen in Manchester and its neighbourhood, the follow-

* Page 107, first edition. † Loc. cit.

ing are the relative proportions, according to Dr. Henry:

Of lithic acid chiefly			71
Of oxalate of lime			11
Of cystic oxide			2
Of the phosphates pure, and constituting the entire calculus		4	22
Of the phosphates less pure, mixed with lithic acid, &c.		18	
Alternating calculi composed of	Lithic acid and phosphates	39	73
	Oxalate of lime and phosphates	16	
	Oxalate of lime and lithic acid	11	
	Oxalate of lime, lithic acid, and phosphates	7	
Compound or mixed calculi			8
			187*

Mr. R. Smith, of Bristol, has lately published a very excellent paper on the subject of calculi, entitled "A Statistical Inquiry into the Frequency of Stone in the Bladder, in Great Britain and Ireland."† In this paper, the following table is given of the calculi preserved in the collection of the Bristol Infirmary. The collection, exclusively of those formed on foreign substances, consists of 218 specimens from the human bladder.

Of lithic acid, nearly pure			74
Of oxalate of lime, nearly pure			33
Of the phosphate of lime, nearly pure		1	20
Of the ammoniaco-magnesian phosphate		1	
Of the fusible calculi, or mixed phosphates		18	
Alternating calculi.	Oxalate of lime and lithic acid	29	83
	Lithic acid and phosphates	12	
	Oxalate of lime and phosphates	32	
	Composition not all mentioned	10	
Compound calculi			8
			218

* Med. Chirurg. Trans. x. p. 127. † Ibid. xi. p. 1.

Table exhibiting a general view of the preceding data.

General character.	Particular Species.	Hunterian Museum, Mr. Brande.	Norwich, Dr. Marcet.	Guy's Hospital, Dr. Marcet.	Manchester, Dr. Henry.	Bristol, Mr. Smith.	Particular Totals.	General Totals.
Lithic acid	Nearly pure	16	66	16			98	
	Mixed with a little oxalate of lime	—	—	6	71	74	6	294
	Mixed with a little of the phosphates	45	—	—			45	
Mulberry	or oxalate of lime ..	6	41	22	11	33	113	113
Cystic oxide..	—	—	—	1	2	—	3	3
Phosphates	Nearly pure........	12	—	—	4	—	16	
	Mixed with a small proportion of the lithic acid	66	—	—	18	—	84	
	Phosphate of lime nearly pure	—	4	3	—	1	8	202
	Triple phosphate, nearly pure.....	—	—	2	—	1	3	
	Fusible, or mixed calculi	—	49	24	—	18	91	
Alternating Calculi	Lithic and mulberry	—	15	—	—	—	15	
	Mulberry and lithic	—	—	—	11	29	40	
	Lithic and phosphates	—	—	—	39	12	51	
	Mulberry & phosphates	—	1	—	16	32	49	
	Lithic, mulberry, and phosphates	—	—	—	—	—	—	186
	Mulberry, lithic, and phosphates	5	—	—	7	—	12	
	Fusible and lithic...	—	1	—	—	—	1	
	Fusible and mulberry	—	2	—	—	—	2	
	Composition not mentioned......	—	—	6	—	10	16	
Compound Calculi	Mixture not mentioned	—	2	7	8	8	25	25
		150	181	87	187	218		823

In the preceding table, the whole of the data are collected into one point of view, under the

general titles of *lithic acid, mulberry, cystic oxide, phosphates, alternating* and *compound calculi;* each of which we shall now proceed to consider in detail.

1. *Lithic acid calculi.* Under this head are classed all those calculi in which this principle evidently predominates, and the general table indicates that somewhat more than $\frac{1}{3}$ of the whole number belongs to this class, a proportion that holds good likewise of each of the individual collections, except that at Guy's Hospital, where the proportion is only one fourth.

But if we take into consideration the fact universally admitted by all authors upon this subject, that lithic acid constitutes by far the most common nucleus round which other calculous matter is subsequently deposited, we may, I think, safely assert, that at least *two thirds* of the whole number of calculi originate from lithic acid; that is to say, if a lithic acid nucleus had not been formed and detained in the bladder, two persons at least out of three who suffer from calculus would have never been troubled with that affection. This is a most important fact, and deserves to be constantly borne in mind.

It has been stated in the preceding chapter, that the urinary sediments in which the lithic acid predominates are of two descriptions, *amor-*

phous and *crsytalline*, and that the amorphous consists chiefly of the lithate of ammonia, and the crystalline of lithic acid nearly pure; now this distinction appears to me to hold good with respect to lithic acid calculi, some being composed of the amorphous sediments and some of the crystalline, but by far the greater number of a mixture of the two. It is with the greatest deference that I presume to differ from the eminent chemists who have preceded me in this field, but I am reluctantly compelled to do so on the present occasion. I have elsewhere shown, that calculi exist composed almost entirely of the lithate of ammonia, and I think it may be asserted that all lithic calculi which have an amorphous or earthy fracture, contain more or less of the same compound. Even the most superficial observer must have remarked, that lithic calculi differ exceedingly in their sensible properties; that some are of a deep fawn colour, distinctly laminated, and exhibit a perfectly *crystalline* fracture; that in others these characters are less distinct, or sometimes entirely disappear; the colour being pale brown, or clay-like, and the fracture perfectly earthy, or amorphous. Every one, I repeat, must have remarked this circumstance, and the natural inference appears to be that the red crystalline calculus is composed of the

red crystalline gravel, and the earthy amorphous one, of the amorphous sediments; and this inference seems to be justified by experiment; the crystalline calculus being, according to my experiments, composed of nearly pure lithic acid; and the amorphous one of lithic acid, more or less of ammonia, generally a little of the phosphates, and sometimes a small portion of the oxalate of lime. The lighter the colour, the greater in general the proportion of lithate of ammonia and the phosphates.

The data in our possession do not enable us to determine the comparative prevalency of these varieties of lithic calculi; but, according to my own observations, those composed of a mixture of the crystalline and amorphous sediments are the most common; while the well-marked crystalline variety is comparatively more rare; and the third variety, or those composed of pure lithate of ammonia, are still more uncommon. The most perfectly crystalline variety I think, is to be generally found among the largest specimens; a circumstance, perhaps, that will not appear difficult to be explained hereafter.

2. *Oxalate of lime, or mulberry calculi.* On comparing the general totals in the preceding tables, it will be found that the mulberry calculi constitute rather less than $\frac{1}{7}$ of the whole number. The proportion, however, differs exceedingly from this and from one another in the

different collections. Thus of the 150 calculi examined by Mr. Brande, only six were composed of the oxalate of lime, or $\frac{1}{25}$ of the whole; and even the most pure of these are stated to contain as much as 35 per cent. of other matter; he accordingly remarks that he had rarely met with it. In the Norwich collection, on the contrary, nearly $\frac{1}{4}$; and in the eollection at Guy's, even somewhat more than this, according to Dr. Marcet, are of the mulberry species. In the Manchester collection only $\frac{1}{17}$ consists of oxalate of lime, nearly pure; but if we take into account all those that contain this substance, the proportions will be found to constitute about $\frac{1}{4}$ of the whole collection, as in those of the Norwich and Guy's Hospital. In the Bristol collection rather less than $\frac{1}{6}$ of the whole consists of oxalate of lime, nearly pure; but if all be included, containing that salt, $\frac{5}{12}$, or nearly *one half* of the whole, will belong to this class! Thus it appears, that in the district of which Bristol may be considered as the centre, this species of urinary deposite is far more frequent than any other, and much exceeds its usual relative proportions, as observed in other parts of the kingdom. The infrequency of this species of calculus in the Hunterian collection, constitutes an anomaly that appears at present inexplicable.

3. *Cystic oxide calculi.* The rarity of this species

of calculus is such, that only 1 in 274 appears, from the data before us, to be of this description; and I think it not improbable that even this estimate is greater than the truth; since three out of the five collections contain no specimen of it.

4. *Calculi composed of the phosphates.* From the data in our table it will appear that about $\frac{1}{4}$ of the whole number of calculi consist of the phosphates, and that half of this proportion, or about $\frac{1}{8}$, consists of the mixed phosphates. But, whoever has paid much attention to the subject of urinary calculi, will perceive that these estimates are very incorrect, especially as far as regards the proportion of the calculi composed of the mixed to those composed of the pure phosphates. It may be observed also, that calculi have frequently the appearance externally of being composed of the phosphates, while they contain a nucleus of a very different substance: except, therefore, calculi are sawn through the centre, it is impossible to ascertain their composition where the phosphates are concerned. Now, in the above data all the calculi, except some examined by Dr. Marcet, at Norwich, appear to have been sawn through;* there cannot, therefore, be

* Dr. M. expressly states that some in the Norwich collection were not cut through: but he is silent on this point with respect to the collection at Guy's. The calculi of the other collections are stated by the authors to have been divided.

much inaccuracy from that cause; yet great confusion arises respecting the comparative frequency of this species of calculi, from the different methods of examining and arranging them adopted by different authors. Thus, from the method followed by Mr. Brande, it is impossible to infer whether the lithic acid, which he states the calculi he examined to have contained, was derived from a lithic acid nucleus, which is most probable, or whether from the whole calculus through which it was equally diffused.* The description of the collection at Norwich does not enable us to draw any inference, with respect to the point in question, for the reasons above given; but in that of Guy's Hospital, no less than 24 out of 87 are stated to belong to the fusible species. Here it is evident that Dr. M. must mean *externally;* for he admits himself elsewhere, in common, I believe, with every other author who has written on the subject, that lithic acid constitutes by far the most frequent nucleus round which the other substances concrete. We may, therefore, I think fairly infer that a large proportion of those calculi placed by Mr. Brande and Dr. M. under the head of the phosphates, have

* Mr. Brande informs us, that "To injure these calculi as little as possible, they were carefully cut through with a fine saw, and a portion of the whole cut surface removed by a file. In this way all the different ingredients of the calculi were obtained."

a lithic acid, or oxalate of lime nucleus, and consequently belong to the class of alternating calculi; an inference that will be much corroborated by the Manchester and Bristol collections, where these points appear to have been particularly attended to. Thus, Dr. Henry says, that "*in four instances only out of* 187, *the calculus has been composed throughout of the earthy phosphates*, and in these I have not been able to discover a nucleus of any other substance;" but his table contains 18 more, or 22 in all, composed almost entirely of the phosphates; so in the Bristol collection only 20 are stated to consist principally of the phosphates, without, however, any reference to their nuclei, which, of whatever they may consist, we may infer, from the principles of arrangement adopted by Mr. Smith, to be very small. From these observations, then, I think we are entitled to conclude, that the proportion of calculi composed essentially of the phosphates is much less than what it appears to be from the data above given taken collectively, and that those composed *entirely* of the phosphates bear even a very small proportion to those composed principally of them: and this inference fully accords with my own observations on the subject.

5. *Alternating calculi.* These constitute by far the most interesting and important species of calculi, in a pathological point of view, since they

present us with a faithful record of the order of succession of the different diatheses, &c. They deserve, therefore, to be most carefully studied; and my readers will, I trust, in consequence, excuse me for entering rather minutely into the subject.

From the preceding data taken collectively, it appears that between $\frac{1}{4}$ and $\frac{1}{3}$ of the whole number belong to the class of alternating calculi; but that this is a very erroneous view of the subject, will be obvious to every one, even from a superficial examination of the data themselves. Thus, there appears to be only five calculi in the Hunterian collection which, according to Mr. Brande's table, belong to the class of alternating calculi; in the portion of the Norwich collection examined by Dr. Marcet, only 19, or about $\frac{1}{6}$ of the whole; and in the collection at Guy's Hospital, according to the same gentleman, only six, or about $\frac{1}{14}$ of the whole; while in the Liverpool collection, according to Dr. Henry, there are no less than 73 belonging to this class; and in the Bristol, according to Mr. Smith, 83, or between $\frac{1}{3}$ and $\frac{1}{2}$ of the whole number. These differences I have no doubt chiefly arise from the different manner in which the calculi have been arranged by the respective authors, and not from actual differences, at least so great, in the proportion of alternating calculi; for in every collection which I have seen, the proportion

of alternating calculi has been strikingly great. But it would be useless to dwell on this part of my subject any longer: I shall, therefore, proceed to examine the different varieties in detail.

a. Lithic and Mulberry. In the Norwich collection, according to Dr. Marcet, no less than 15, or $\frac{1}{12}$ of the whole number examined by him, consisted of calculi of this description, whereas in neither of the other collections is this variety stated to exist. From the manner in which the results are stated with respect to the Hunterian and Guy's Hospital collections, we are indeed unable to decide whether such a variety exist in them or not; but in the Manchester and Bristol collections, there is evidently no such variety: a circumstance of a very singular nature, and pointing out a most striking difference between the diatheses prevalent in the eastern and western parts of the kingdom. I have dissected, and examined with great care, a calculus composed of lithic acid, oxalate of lime, and afterwards lithic acid again, with the view of ascertaining the nature of the transition from one species to the other. The change appeared to take place almost *ex abrupto*, that is to say, on the surface of the lithic calculus, which was a well-marked crystalline one, there was a very thin layer of a lighter colour composed of lithic acid, lithate of ammonia, and oxalate of lime intermixed, and upon this the

oxalate of lime was immediately deposited in the crystalline state. The transition back again from the oxalate of lime to the lithic acid, was still more abrupt, and absolutely without any perceptible intermediate state that I could observe; a plain proof, I presume, that *some time must* have elapsed between the deposition of the different calculous matters. The oxalate of lime in this instance consisted of two distinct laminæ; the internal of which was beautifully crystallized in the form of rays perpendicular to the surface of the calculus, while the external consisted of a congeries of distinct crystals (some of them almost transparent), which rendered the external surface slightly rough and tuberculated.

b. Mulberry and Lithic. It is no less remarkable that this variety of calculus is not stated to exist either in the Hunterian, Norwich, or Guy's Hospital collections, though in the Bristol collection it forms nearly $\frac{1}{7}$ of the whole number, and in the Manchester $\frac{1}{17}$. The transition from the mulberry to the lithic sometimes takes place at once, as in the specimen just described; but occasionally a mixture of the two substances occurs between the pure mulberry and pure lithic.

c. Lithic and Phosphates. This common variety of calculus is not stated to exist either in the Hunterian, Norwich, or Guy's Hospital collections. We can hardly, however, infer from this

that it does not occur there, but must suppose that it has been included under other heads. In the Manchester collection it constitutes between $\frac{1}{4}$ and $\frac{1}{5}$ of the whole number, and in the Bristol only about $\frac{1}{18}$, a remarkable and striking difference, on which a few remarks will be made when speaking of the next variety. The usual transition from the lithic acid to the phosphates is most interesting and instructive. If the calculus has originally been of the crystalline variety, the first symptom of change is commonly the disappearance of the crystalline character, and the substitution of the amorphous one in its stead; at the same time the colour becomes paler. These characters gradually increase till the fracture becomes perfectly amorphous, and the colour a pale clay-brown, and very soon after this the phosphates appear to prevail entirely. These changes indicate that the transition from lithic acid to the phosphates, take place through the lithate of ammonia, and that it is accompanied by the disappearance of the usual colouring principle from the urine. It may, however, be remarked that we rarely meet with the above series of changes complete, the perfectly crystalline variety of lithic acid seldom passing to the phosphates; while, on the contrary, the pale amorphous variety frequently passes into the phosphates, or contains them mixed. Sometimes, also the series of changes occurs in a very limited space.

d. Mulberry and Phosphates. In the Hun-

terian, Norwich, and Guy's Hospital collections, this variety of calculus hardly appears to occur; while in the Bristol it forms upwards of $\frac{1}{7}$ of the whole, and in the Manchester $\frac{1}{11}$. The striking difference between the Manchester and Bristol collections, consists in the great number of the mulberry species in the latter, while in the Manchester collection the lithic species predominates. This is a very curious fact, the origin of which is probably to be traced to some difference in the modes of living between the two districts. The transition from the mulberry to the phosphates is sometimes most interesting and instructive: the following is what I have observed on dissecting and analyzing this variety. The nucleus had the usual appearance and composition of the mulberry calculus. Round this was deposited a substance of a less compact and more friable texture, composed of a large proportion of carbonate of lime, mixed with some oxalate of lime; at a greater distance from the centre, the oxalate of lime entirely disappeared, and its place began to be supplied by the phosphate of lime; the compound here, therefore, consisted chiefly of the carbonate and phosphate of lime. Still further from the centre, the carbonate of lime was much less in quantity, and at length altogether disappeared, and the calculous matter consisted almost entirely of phosphate of lime, with a small proportion of the triple phosphate and animal matter: and of this the bulk of the calculus con-

sisted. It was very difficultly fusible. This calculus was extremely friable, and had been broken to pieces in extracting.

e. Lithic, Mulberry, and Phosphates. It is singular that neither of the collections should be stated to contain a specimen of this variety, which is by no means uncommon. In the seventh plate of Dr. Marcet's work, there is a good figure of a calculus of this description.

f. Mulberry, Lithic, and Phosphates. In the Hunterian collection, five specimens of this variety are stated to exist; in the Manchester seven. We are unable from the data to state whether any specimens exist in the other collections, but there can, I think, be little doubt of the fact. In the Bristol collection there are ten specimens of alternating calculi, the nucleus of all of which is stated to consist of oxalate of lime. One of these specimens is made of four regular deposites, namely, oxalate of lime, lithic acid, oxalate of lime and lithic acid mixed, and externally "ammoniaco-magnesian phosphate of lime," a term of which I am at a loss to comprehend the meaning, except it be intended to signify the mixed phosphates.

g. h. Fusible and Lithic. Fusible and Mulberry. Out of 823 calculi, the aggregate of all the collections, only *three* specimens are stated to exist in which the phosphates have been fol-

lowed or surrounded by other calculous deposites. The *law, therefore, that a decided deposition of the mixed phosphates, is not followed by other depositions, appears to be general,* and a most important one it is, as we shall find hereafter. In all the numerous calculi that have fallen under my own observation, I do not recollect a decided exception to it; for in every instance in which there appeared at first sight to be an exception, it was found, upon a closer examination, to be more apparent than real. The following is a description of a calculus constituting such an apparent exception. The nucleus was composed of a loose aggregate of particles, composed principally of the lithate of ammonia, of a pale brown colour. Round this was deposited a layer of considerable thickness, composed almost entirely of the same substance, but hard and compact; without this was deposited an imperfect lamina of the triple phosphate of magnesia and ammonia; and beyond this, several thin and irregular laminæ of the lithate of ammonia and triple phosphate, intimately intermixed with one another: lastly, the whole was covered by a layer of the triple phosphate of magnesia and ammonia, perfectly white, and of a crystalline texture, and consequently nearly pure. Thus, in fact, this hardly constituted an exception to the general law; for, as will be hereafter shown, the lithate of ammonia seems to constitute, as it were, the interme-

diate link between the lithic acid and phosphates.* Besides these varieties of alternating calculi, it is obvious that many others *may* exist, and probably do so. Indeed there are descriptions of such calculi on record. Thus, Dr. Marcet gives a figure of a small one, composed of lithic acid in the centre, bone earth next, then oxalate of lime, and lastly, the mixed phosphates.† Such varieties, however, are rare, and may be rather considered as curiosities than otherwise important.

6. *Compound calculi.* Calculi termed compound, from being composed of different ingredients mixed up together, are comparatively rare. From the aggregate of the preceding data, it appears that about $\frac{1}{33}$ of the whole number only is of this description. But the proportion in the collection of Guy's Hospital, is no less than nearly $\frac{1}{12}$, while in the Norwich it is only $\frac{1}{90}$, a prodigious difference, for which there is no apparent reason. It is to be regretted also, that neither of the authors has informed us of what these compound calculi are composed. Are they composed of the same mixture, or of different ones? The answer would be most important, as it would show us what dif-

* This calculus was the second taken from a young gentleman; the first of which consisted principally of the lithate of ammonia, and whose case is alluded to in a paper published by me on this species of calculus.

† See plate viii. fig. 8, of his work on calculous complaints.

ferent diatheses can exist together at the same time, and thus, perhaps, throw more light on those affections in general after alternating calculi, than almost any other facts connected with this interesting and important subject. For my own part, I have nothing from my own experience to offer on this head. I have never seen, or rather examined, what I should denominate a compound calculus. I have indeed observed, in the transition stages of calculi, an intervening portion composed of a mixture of the old and the new layers; but this in general has constituted a very small proportion of the entire calculus. Such mixtures have consisted, for example, of the lithate of ammonia and the oxalate of lime; of the oxalate, carbonate, and phosphate of lime; of the lithate of ammonia, and the mixed phosphates, &c.; but never of pure lithic acid with any other ingredient, and particularly with the phosphates; nor do I believe such a compound ever existed in nature.

Such is a summary account of the mechanical deposites from the urine, and the various forms they assume, their comparative frequency, &c. The reader, however, will readily perceive that, although so different in their composition and appearance, they may in fact be considered as made up of four elementary substances only, viz. 1. *The lithic acid and its compounds.* 2. *The oxalate of lime.* 3. *The cystic oxide: and,* 4. *The earthy phosphates,*

two or more of which principles are seldom or never found in excess in the urine at the same time. Hence they may be supposed to represent so many distinct diatheses, or conditions of the system requiring to be separately considered; and this accordingly is the principle on which the future arrangement of my subject will be founded. The preceding order has been adopted for the following reasons: The lithic acid or its compound, the lithate of ammonia, not only constitutes the most frequent constituent of calculi, but is that which most generally gives origin to the other species, by furnishing a nucleus round which the matters composing them may concrete: it may, therefore, justly claim to be considered in the first place. Next to the lithic acid, the oxalate of lime species of calculus seems to possess most strongly the characters of an original diathesis, from the frequency with which it gives origin to renal nuclei. The cystic oxide is extremely rare; but, it seems to originate most frequently in the kidney, and moreover has the property when present of excluding other diatheses. The phosphates naturally fall to be considered in the last place, from the circumstance that they very rarely constitute entire calculi, but *succeed* to the other diatheses, and are themselves very rarely if ever succeeded by any other diathesis.

CHAP. III.

Of the Lithic Acid Diathesis in general, and on the best Means of counteracting it, so as to prevent the original Formation of Calculus, or its Recurrence after an Operation.

IT has been before stated, that lithic acid is separated from the urine under two distinct forms; first, as an amorphous, or uncrystallized sediment, in which it is always in some state of combination; and, secondly, in a crystalline form, and nearly pure. These circumstances naturally induce us to consider the subject under two points of view; and,

1. *Of amorphous sediments.* The amorphous sediments at present under consideration consist essentially, as has been before stated, of lithic acid, in combination with some base, generally *ammonia.* In healthy urine this compound exists in such a proportion, as to be held in permanent solution at all ordinary temperatures. From particular causes, however, affecting the health, the quantity of lithate of ammonia in the urine is increased above the natural standard; and in this case the *excess* is deposited as the urine cools, and

thus constitutes the sediments in question. Such is an explanation of the phenomenon in its general and most simple form; and the obvious conclusion to be drawn from it is, that the deposition of amorphous sediments is indicative of an *excess* of lithic acid in the urine.* Before, however, we proceed to consider the subject more particularly, we have first to inquire generally what is the state of the health connected with an *excess* of lithic acid in the urine.

In attempting to answer this question, I shall first enumerate the circumstances (excluding, of course, actual disease) which I have observed to produce this excess of lithic acid in a person subject to slight dyspepsia, but in other respects healthy, and who, consequently, from his susceptibility to the operation of the exciting causes, may be considered in the light of a *delicate test* of their presence and action. These exciting causes are of three kinds—*a*. Simple errors in diet; *b*. Unusual or unnatural exercise, either bodily or mental, particularly after eating, and the want of proper exercise at all other times; and, *c*. Debilitating circumstances.

* I wish to state that I have adopted this general view of the subject chiefly from its simplicity and convenience. The deposition of amorphous sediments, for the most part, indicates an *excess* of lithic acid in the urine, but by no means *universally* so; for they appear to be sometimes deposited in consequence of a very slight excess of acid in the urine.

a. Errors in diet may consist either in a simple excess of the usual wholesome articles of food, or in the partaking of food which is unwholesome, or which uniformly disagrees with an individual. With respect to an excess of wholesome food, I have observed, first, that all other circumstances being the same, an unusually heavy meal especially of animal food or of bread, is *invariably* followed by a deposition of the lithate of ammonia from the urine. Secondly, that the circumstances of quantity and quality of food being the same as usual, an abrupt or decided change in the time of partaking of it, such, for example, as dining at noon, or eating supper (to which the person is not accustomed), will very frequently produce the same effect: and, lastly, that the same effect is occasionally produced by partaking of food to which the person has not been used, though wholesome in itself, and taken at the usual times and in moderate quantity.

With respect to the *wholesomeness* of food, so much depends upon idiosyncrasy, that this point can only be determined in many instances by actual trial. Whatever agrees with the stomach of an individual, when taken in moderate quantity, may perhaps be presumed to be easily digested, and therefore *wholesome* as far as regards that individual; and the stomachs of different persons are so various and capricious in this respect, that there is scarcely any kind of food but some

stomach may be found capable of digesting it. Certain substances, however, are universally acknowledged to be more difficult of digestion than others. These are enumerated by writers on dietetics, and are sufficiently well known. I shall therefore only notice one or two substances which, of all others, have been observed most apt to produce a deposition of the lithate of ammonia: these are animal substances in general, and more especially heavy, unfermented bread, or compact, hard-boiled fat dumplings or puddings.

b. Unusual or unnatural exercise of the body or mind, particularly after eating, and the want of proper exercise at all other times. It has been observed, that horse exercise is apt to produce a turbid state of the urine, in those who are unaccustomed to it. I have also remarked, that exercise in general, whether bodily or mental, taken immediately after a principal meal, as after dinner, is almost invariably followed by a deposition of the lithate of ammonia from the urine. On the contrary, the want of active exercise after a certain stage of the digestive process has been completed, is very frequently followed by a similar deposition. I have likewise remarked, that even a moderate meal taken after a day spent in close mental application, or complete bodily inactivity, is very frequently succeeded by the same event.

c. Debilitating circumstances. To this class

belong a great variety of unconnected events having no principle in common except that, perhaps, of diminishing the vital energies, such as various medicinal substances; certain conditions of the atmosphere; also depressing passions of the mind, inordinate mental or bodily fatigue, long fasting, and a host of others which need not be enumerated; all of which, the quantity and quality of the diet, &c. remaining the same, will frequently occasion the deposition in question from the urine.

These are the principal circumstances which, independently of actual disease, seem capable of producing a deposition of lithate of ammonia from the urine. Let us now inquire a little into their nature and mode of operation.

In the first place, with respect to a simple excess in wholesome and natural diet, this can be only supposed to act in virtue of its quantity; that is to say, the digestive and assimilating organs have more given them to do than they can do well; or if they can perfectly execute their office, the quantity of nutriment is greater than may be necessary for the purposes of the animal economy; and the imperfect or superfluous matter may be supposed to be separated by the kidney under the form of lithic acid. When the food is unnatural, something very similar may be supposed to take place; that is, the digestive and assimilating organs may be presumed to be unable to render it

proper for the nutriment of the body. With respect to the circumstances of taking food at unusual hours, or of food to which the stomach has been unaccustomed, their effects may be probably explained on similar principles. The animal economy is the slave of habits; and, when these are rudely broken in upon, the different organs are liable to have their functions deranged, and consequently the operations depending upon them imperfectly performed.

As to exercise, we are taught by nature, in common with all other animals, to remain in a state of rest for some time after meals. This is obviously a wise provision intended to secure a due digestion of our food; and the infringing of it, as is universally known, cannot happen with impunity. These remarks apply equally to the exercises of the mind.—Who, for example, is fit for study immediately after dinner? On the contrary, when the food has been duly digested, and the nutritious portion of it has perhaps entered the circulating system in the form of chyle, a certain degree of bodily exercise appears to be necessary to complete its assimilation. Then it is that animals are roused from those slumbers into which they naturally subsided after eating, and betake themselves to action: then it is that we feel, if ever we do, a sense of renovation and aptness for muscular exertion: then it is, in

short, that we *ought to be active.* Unfortunately, however, for mankind, this impulse for action, though for the most part equally striking as that for rest, is not equally imperious. Hence we are too apt to overlook its nature and object, and regard it as nothing more than a healthy sensation by which we are summoned to that occupation to which inclination or duty prompts us. Thus, instead of being *bodily active,* the studious man regards it as a summons to be *mentally active,* or the indolent man perhaps to merely *sit up and enjoy himself,*—in short, this feeling of renovated energy is used or abused in a thousand ways by different individuals, without their ever dreaming that *bodily exercise, and that alone,* is implied by it. The result is, that imperfect assimilation, and all its consequences, take place; one of the most constant of which, as before stated, is turbidity of the urine from an excess of lithate of ammonia.

All circumstances which debilitate, all diseases, therefore, and particularly fever, are well known to affect the digestive and assimilating functions most powerfully. Hence, under such conditions of the system, an ordinary meal becomes an *excess,* and will be naturally attended by the same consequences. It must be equally obvious, also, that when the stomach and digestive organs are so debilitated, that they must be much more sus-

ceptible to all those circumstances which can derange their operations than when in a healthy state.

These observations appear to throw no small light upon the question under consideration; and their general import seems to be that a deposition of the lithate of ammonia in the urine is connected with some derangements of the digestive and assimilating functions. In what this derangement immediately consists I cannot take upon myself to say; but it apparently consists in some *defect* in the operations of those organs; by which either chyle too imperfect for the purposes of the economy, or some new and unnatural principle is generated, which, requiring to be removed from the system, is thrown upon the kidney, and by that organ converted into lithate of ammonia.* Whether the kidney partakes in the diseased action is doubtful, at least in ordinary cases. We see that this organ *naturally* secretes the lithate of ammonia. Its operation can therefore be supposed to be deranged *in degree only:* and it appears

* It is, I believe, the common opinion, that all sorts of red amorphous sediments are produced by fever. I shall not dispute this point, though I doubt its general accuracy. When fever occurs in healthy subjects, it is indeed accompanied by these sediments, even where they cannot be ascribed to diet. In such cases it is probable that the quality of the blood already formed is changed by the febrile action, and that some portion of that fluid is reduced to the state in which it is adapted for forming lithate of ammonia.

probable, from this and other circumstances that might be mentioned, that when imperfectly assimilated or unnatural albuminous matter, such as that above alluded to, is brought to the kidney, that organ *does*, and *must*, in virtue of its natural action, convert such imperfect albumen into lithate of ammonia. Whether, under certain circumstances, the kidney be capable of forming lithate of ammonia from matters different from those above supposed, is another question, and one that we are quite unable to answer at present. My own opinion is, that the kidney cannot form lithate of ammonia, or any other principle, from whatever may be presented to it indiscriminately; but that it must have the ingredients prepared for its operation in some uniform and peculiar manner.

After these general remarks upon the nature and cause of amorphous sediments, we come now to consider the subject more particularly. Every one who has paid the least attention to the urine, must be aware that these sediments assume, at different times, very different appearances, especially in point of colour; and that they occur at different times, and in different persons, of almost every shade of colour, from nearly perfectly white to deep mahogany brownish red. This variety in appearance is doubtless connected with corresponding modifications in the diseases from which they originate; but as it would be endless, or impossible, to

point out all those modifications, I shall consider them under three heads only, which will be found quite sufficient for all practical purposes, namely—1. *Yellowish or nut-brown* sediments; 2. *Reddish brown or lateritious* sediments; and, 3. *Pink* sediments.

1. *Yellowish or nut-brown sediments.* These sediments vary in colour from nearly white to the *wood brown* of Werner—a colour which is stated to be identical with that of ripe hazle nuts. They consist essentially of the lithate of ammonia, tinged with the colouring principle of the urine, but usually contain more or less of the phosphates, and sometimes a little of the lithate of soda. In general, perhaps, the nearer they approach to white, the more of the phosphates they contain: but there are many exceptions to this; and I have seen sediments belonging to this class almost perfectly white, and consisting of nearly pure lithate of ammonia.

This class of sediments may be termed the *sediments of health,* if the term may be allowed—being such as are produced in the urine of healthy or slightly dyspeptic individuals by errors of diet, and all the other circumstances before mentioned, which seem, independently of actual fever, to produce turbid urine. Perhaps there is no healthy individual whose urine does not occasionally deposit this species of sediment. There are some,

however, infinitely more liable to it than others, and who consequently have it induced by the slightest causes. This susceptibility obviously denotes a tendency to an excess of lithic acid, and its consequences: but when these sediments are of an unusually pale colour, as is sometimes the case, a tendency to the phosphates is indicated, as will be more particularly pointed out hereafter. Children are very subject to this form of sediment; and in them, as well as in all who labour under such a susceptibility, it is almost constantly the forerunner of gravel or calculus. Indeed, nothing is more common than for this form of sediment to alternate in the urine of the same person with the crystallized sediment or *gravel* to be presently described. Pale coloured varieties of this class of sediments, when abundant, and when there is a slight excess of acid in the urine, often subside to the bottom of the vessel in the form of a gelatinous-looking mass, which soon begins to assume either an amorphous or imperfectly crystalline form, at first on its surface, and afterwards gradually throughout its substance. This appearance, which also occurs in other forms of sediments, though more rarely, has been commonly attributed to mucus.

2. *Reddish brown or lateritious sediments.* These sediments vary in tint from nearly white, in which state they are with difficulty distinguished

from the last variety, to a deep brick red or brown. They consist essentially of the lithate of ammonia, or lithate of soda, tinged with a large proportion of the colouring principle of the urine, and more or less of the purpurates of ammonia and soda. Sometimes, also, they contain a small proportion of the earthy phosphates. In general the deeper the tint, and the more approaching to *brick red*, the more of the lithate and purpurate of soda they contain: but there are some exceptions to this observation.

When the purpurates exist in the urine (indicating, as was formerly attempted to be shown, the secretion by the kidney of nitric acid), *feverish* or *inflammatory* action is almost constantly indicated: and this law is so general, that I have never seen a decided exception to it. The presence, therefore, of this class of sediments may be supposed to denote fever, and generally, I believe, of an active inflammatory nature. They owe their peculiarity of tint to the colouring matter of the urine, which, in common with all its other principles, appears on such occasions to be secreted more copiously than usual. Hence, urine which deposits these sediments is usually of a deep red or brown colour, and of high specific gravity. The deeper the colour of the sediment, and the more approaching to *red*, the more severe in general the symptoms: and it may be mentioned, that the most decided

and strongly marked specimens of this kind of sediment which I have seen, have been deposited by the urine of gouty individuals; in which case, as before observed, the sediments consisted chiefly of the lithate of soda, and the tinging substance, from the tint, appeared to be the purpurate of soda. The urine of all persons labouring under fever and inflammatory affections, and whose urine is naturally healthy, is liable to deposit this species of sediment. Those however, who are most subject to the first variety, seem to be more liable to this, especially to the paler varieties of it. Such persons appear to be naturally of a feverish, irritable habit; and are apt to be excited by the slightest causes, such as trifling errors in diet, a chilly state of the atmosphere, &c. There are certain diseases, also, in which this variety of sediment appears to occur in a greater degree, and in a more decided form, than usual: such are gout, as above-mentioned; also rheumatism, hepatic affections, &c.

3. *Pink sediments.* The third variety of amorphous sediments, is what is usually denominated *pink* sediments, the colour of which is very aptly expressed by the term *pink.* Like the other varieties, they consist essentially of the lithate of ammonia; but they differ from both these in being almost entirely devoid of the yellow tint derived from the colouring matter of the

urine; and consequently, in owing their colour chiefly to the purpurate of ammonia. This class of sediments, therefore, appears to indicate the absence of the large proportion of the colouring principle of the urine, so constantly present in active inflammatory fever, and to denote the secretion of a greater quantity of nitric acid, and the consequent formation of more of the purpurate of ammonia; and this view of the subject actually coincides with my observations. The most perfect specimens of this kind of sediment which I have ever seen were obtained from the urine of dropsical individuals: they occur also occasionally in the urine of the hectic, and of those obviously labouring under certain chronic visceral affections, especially of the liver.

Such is an outline of the circumstances which have been observed respecting those amorphous sediments composed principally of the lithic acid. To render them, if possible, still more distinct, I shall briefly recapitulate them: Amorphous sediments owe their colours to two classes of substances, differing from one another; the first of these is, apparently, an ingredient of healthy urine, and helps to impart a yellow colour to that fluid. This ingredient is liable to be very much increased in active inflammatory fevers, though, of course, its presence does not necessarily indicate fever. The second source of colour is the purpurates, a class of substances not existing in

healthy urine, but in that only of persons labouring under fever. These two substances naturally give rise to three varieties of sediments: 1. Lithate of ammonia tinged by the colouring matter of the urine only, and not necessarily indicating fever; 2.—tinged by a mixture of an excess of the same ingredient, and more or less of the purpurates, indicating for the most part active inflammatory fever; and, 3.—tinged by the purpurate of ammonia only, indicating generally fever, of an irritable nature, as *hectic?**

It may be also remarked, that the above holds only with respect to the *healthy* action of the kidney. When this organ is deranged, as in diabetes, for example, the colouring principle which usually accompanies the lithic acid, as well as the lithic acid itself, are scarcely secreted at all, and consequently, sediments of the above description cannot take place; in such instances, therefore, fevers can, and do exist, without these appearances.† I wish, also, further to remark,

* The best mode of judging of the real nature of these sediments, is, to collect them on a filter, and examine them while still wet. It is impossible to judge of their precise tint when in the urine; and if permitted to dry, they become much paler, and their colour cannot be completely restored.

† I have, however, seen in a case of common inflammatory sore throat, where the phosphates were usually deposited in abundance, the lithate of ammonia intermixed with them, but in a *perfectly white* state.

that these sediments appear to me to show rather that fever *has existed, and is going off*, than that it *exists at present.* They never appear, I believe, during the first, or cold stage of fever, and properly belong to the last, or sweating stage. In continued fevers, indeed, they sometimes occur almost constantly; but this, I presume, can be explained, upon the supposition, that the sediments, for example, generated by the fever of yesterday, appear in the urine secreted during the remission of to-day; and those generated to-day, in the urine of to-morrow, &c. The length of time which the urine is sometimes retained by feverish patients, and the consequent mixture of portions secreted at different times, has thrown a good deal of confusion on this part of the subject, which a simple attention to the above points will, for the most part, set to rights.

II. *Of crystallized sediments, or gravel.* Crystallized sediments, or red gravel, consists of lithic acid, nearly pure. Lithic acid, as has been before stated, exists in a state of combination in healthy urine; and in such a proportion, as to be held in a state of solution at all ordinary temperatures. Sometimes, however, a free acid is generated by the kidneys, which, combining with the ammonia, precipitates the lithic acid in the pure crystalline state we see it—a phenomenon easily imitated artificially, as is well known, by the

addition of a few drops of any acid to healthy urine. The precipitation of crystallized lithic acid does not, therefore, necessarily indicate an excess of lithic acid in the urine, but the presence only of some free acid in that fluid;* though such an excess does, for the most part, exist in this form of disease, as will be shown hereafter. With respect to the nature of the precipitating acid, I have already made some remarks, and endeavoured to render it probable that it is not constantly the same. Most generally it appears to be the *phosphoric acid,* sometimes the *sulphuric.* I think I have also seen it take place from the nitric and erythric acids, and occasionally from some other acid of a destructible nature, which I was unable to make out: even the carbonic acid may be occasionally the cause of this precipitation.†

* I have frequently seen the urine so completely divested of lithic acid in this form of the disease, that, upon adding to it even an excess of a mineral acid, not another particle of lithic acid has been deposited.

† Since the above was written, I have read, for the first time, a work originally published so long ago as 1786, by Mr. Murray Forbes, entitled "*A Treatise upon Gravel, and upon Gout, in which their Sources and Connections are ascertained, &c.*;" in which opinions very similar to the above, respecting the deposition of amorphous and crystalline sediments, are maintained. Indeed, if this gentleman had been better acquainted with the chemical properties of these substances, there is no doubt but he would have come to exactly the same conclusions. In 1792, Dr. Wilson Philip also published a valuable series of experiments, on the effects

This form of urinary sediment may, or may not, be accompanied by fever. When unaccompanied by fever, its colour is always identical with the deeper tints of that of the first class of amorphous sediments, before described. When accompanied by fever, it is generally more or less of a red or lateritious colour. I have never seen this form of sediment of a *pink* colour, and have reasons for believing that such a circumstance cannot take place.

Crystalline sediments occasionally occur in the urine of healthy individuals, from errors in diet, &c.; but, for the most part, they are habitual, and

of different articles of food, &c. on the urine; in which a similar opinion respecting the deposition of lithic acid crystals, by the presence of a free acid, is maintained; but for this opinion he appears to acknowledge himself indebted to Mr. Forbes. Dr. Philip's experiments have been lately republished, with some additional observations, in the 6th vol. of the "Transactions of the Royal College of Physicians." Dr. Philip is of opinion, that the precipitating acid, in a healthy state of the system, is thrown off by the skin; and he supposes, that even when generated in excess, it may be diverted to the surface of the body by merely increasing insensible perspiration. Though I do not entirely coincide with this opinion of Dr. P., yet, upon other grounds, I fully agree with him in the propriety, and even necessity, of ensuring a due performance of the cutaneous functions in these complaints. It may be remarked, that what Dr. Philip termed *cream coloured sediments* in the first edition of his paper, and *phosphates* in that recently published, evidently consisted in many instances of the lithate of ammonia.

exist for a great length of time together. The symptoms usually attending them, when not in great excess, are generally by no means urgent, and attract but little of the patient's attention. In most instances, they are such as indicate some error in the digestive functions, as acidity of the stomach, flatulence, &c. I have also occasionally heard patients complain, in this form of disease, of a constant sense of heat and dryness in the throat and fauces, inducing a frequent desire to hawk and spit. Generally, also, there is a sense of weight and uneasiness about the region of the kidney, and not unfrequently more or less of irritation about the neck of the bladder and urethra. Sometimes this form of disease is manifestly connected with some local injury, or actual disorganizement, of the kidney.

These observations naturally bring me, in the last place, to make a few remarks on the circumstances usually attending the formation of a nephritic calculus, or what is usually termed a *fit of the gravel.*

The urine of those individuals who possess a disposition to the disease, continues, as just observed, for a great length of time, perhaps almost constantly, to deposit lithic acid in some form or other. This, being accompanied by no very remarkable or severe symptoms, often escapes their observation; they proceed, therefore, in their usual

habits, while the disease insidiously continues to gain ground daily: at length the affection begins to assume its most aggravated form, and both crystallized and amorphous sediments appear in the urine, sometimes in enormous quantities; at the same time, a peculiar state of the system, accompanied by fever, and closely resembling that present in gout, to which it is generally referred, comes on; the urine is now very much diminished in quantity (often amounting almost to suppression), its specific gravity unusually great, its colour very deep, the sediments unusually large (or occasionally they disappear altogether); and under these circumstances, a calculus is formed in the kidney. During the above state, there is commonly a sense of dull pain, or weight, in the region of the kidney; but as this is not particularly severe, it is little attended to; and after a few days the whole gradually subside, or perhaps terminate in an attack of gout. Sooner or later, after the above symptoms (but commonly not till they have subsided, and the urine has begun to be secreted in its usual quantity), the patient is seized all at once, and perhaps without the least warning, with a most acute pain in the region of the kidney, accompanied by violent sickness and vomiting, and other symptoms to be hereafter described, when we come to treat of the mechanical effects of these concretions.

Such is the history of a nephritic attack, as I am convinced I have seen it, and, as it seems most usually to occur. Of course, I cannot positively assert that the nucleus is generated during the existence of the symptoms above described; but I have met with such strong evidence of it, that no doubt of the subject has been left in my mind. I do not see, also, how it is possible to account for the sudden nephritic attacks which frequently take place during perfect health, except on the supposition, that the calculus had been formed before, and had lain for some time in the kidney, which it very frequently appears to do, without producing much pain, or even uneasiness. I admit that it is extremely difficult to get at the truth on these points; the attention of patients being, generally, too much taken up with their present sufferings, to attend to what took place some time before, and particularly to what was slight compared to the present, and, in their estimation, little connected with it. Besides, the calculus might have been formed months or years before, and thus the symptoms attending its formation have altogether escaped their memory.

In recapitulating the circumstances which give origin to these sediments, in general, it may be stated, that they are of two general descriptions, *natural* or *acquired*. With respect to those of the first description, it cannot, I think, be doubted,

that certain individuals are much more liable to these sediments than others. This tendency is not unfrequently inherited; thus, I know a family where the grandfather and father have actually lithic calculi in the bladder; and where the grandson, a youth of twelve or thirteen years of age, has a very strong tendency to the same disease; his urine depositing frequently very large quantities of lithic acid, both in the form of amorphous and crystalline sediments. On the other hand, the disposition to generate these sediments in excess, is, like gout, or rather simultaneously with gout, but too frequently acquired by indolent habits, and excess in eating and drinking. Most frequently, however, the tendency to these diseases, is connected with some unknown causes, peculiar to certain districts or countries, as, for example, the district of which Norwich may be considered as the centre; in which more calculous cases occur than in the whole of Ireland or Scotland. In such instances, the water, diet, temperature, &c. of the district, has been each accused, in its turn, of being the exciting cause: but the circumstance, I believe, still remains unexplained.* I have in one or two instances seen a

* From remarking the very great tendency to deposit lithic acid, produced by hard-boiled dumplings, badly fermented bread, &c. I have sometimes thought, that if such articles constituted a large proportion of the food of a district, its inhabitants might probably be subject to calculous affections.

fit of lithic gravel induced in the predisposed, by sitting on a damp cold seat for some hours. Sometimes also a tendency to lithic calculus is evidently connected with local injury or disease of the kidney.

With respect to the general prognosis in this class of sediments, it may be stated, that amorphous sediments are of a more formidable character, in proportion as they are whiter, or of a more pure pink colour. When pale coloured, they denote, in general, a tendency to the phosphates; and when of a pink colour, generally some organic, or other deeply seated disease. But in drawing our conclusions, other circumstances must commonly be taken into account, and particularly the more or less constant deposition, and the greater or less quantity, of these sediments. A constant deposition of lithic acid crystals in large quantity will almost certainly, sooner or later, end in the formation of a calculus: the occasional deposition of the sediments in small quantity, is seldom attended by much danger.

After these general remarks upon the lithic acid diathesis, its causes, and nature, we come to consider the means by which it is to be counteracted, and its distressing consequences prevented.

Amorphous sediments; first variety. The frequent appearance of this variety of sediment, indicates, as we before stated, a strong tendency to the lithic acid diathesis and its consequences. In ge-

neral it is not accompanied by any prominent symptoms, and fever in particular is altogether absent, or very slight. Hence this state of the affection scarcely requires a formal treatment with medicine, but a careful attention on the part of the patient, to avoid all the circumstances which have a tendency to aggravate the disease; in particular, to avoid those errors in diet, exercise, &c. which have been before stated to frequently give origin to this deposite in the predisposed. Of these, errors in diet, from their being most liable to be constant, are of the chief importance; and the error of *quantity* in diet is of infinitely more importance than the error of *quality*. *Any stomach may digest a* LITTLE *of any thing, but no stomach can digest a* GREAT DEAL *of any thing.* This is a maxim that ought to be universally borne in mind where diet is concerned, and is in particular of the very first consequence in the present diseases. I do not mean that individuals subject to these affections should indulge themselves with a little of whatever comes in their way; such a licence, from the modes in which the term *a little* would be construed by different individuals, would be exceedingly dangerous: on the contrary, they should abstain altogether from things which manifestly disagree with them, and which must be unwholesome to all, such as heavy unfermented bread, hard boiled and fat puddings, salt-

ed and dried meats,* acescent fruits, and (if the digestive organs be much debilitated) soups of every

* It may not be improper here to make a few general remarks upon the cooking of provisions by the common processes of boiling and roasting. Every one knows that the longer an egg is boiled within certain limits the harder it becomes. Now the muscular fibre of animals is composed of an albuminous principle possessed of precisely the same properties. Beef, for example, boiled too fast or too long, becomes, like an overboiled egg, so hard, as to be rendered very difficult of digestion. Young meats, on the contrary, as veal, are reduced by long boiling to a gelatinous substance, the easy digestibility and wholesomeness of which, in my opinion, is very problematical. Nearly the same remarks apply to roasting, which is but another mode of imparting the effect of heat. The case is somewhat different with respect to vegetables; but even here great mistakes are often committed. Thus, potatoes are most generally boiled to the state of a dry insipid powder, instead of being preserved in that state in which the parts of which they are composed are rendered soft and gelatinous, so as to retain their shape, yet be very easily separated: and of vegetables it may be remarked, in general, that if they require a great deal of boiling to render them soft, they are for the most part difficult of digestion and little nutritious. The fact is, that the boiling temperature is too high for a great many of the processes of cooking, and that a lower temperature and a greater time, *or a species of infusion* are better adapted for most of them. This is notorious with substances intended to be *stewed*, which even in cookery books are directed to be *boiled slowly*, (that is, not at all,) and for a considerable time. The ignorance and prejudice existing on these points is very great, and combatted with difficulty; yet when we take into account their import-

kind, &c. In general also, wines, and particularly those of an acescent quality, should be avoided. Simple attention to these rules, with respect to diet and exercise, the ensuring a due performance of the cutaneous functions by wearing flannel (particularly about the loins), the preserving a regular state of the bowels, and perhaps the occasional use of alterative medicines, are all that are commonly requisite in this form of

ance, and how intimately they are connected with health, they will be found to deserve no small share of our attention. With respect to soups and other liquid aliments, I perfectly agree with an eminent modern teacher, that they should be taken in very moderate quantity, if not altogether shunned, by those who suffer from affections of the digestive organs. What can be more absurd, for example, than drenching an empty stomach already debilitated, with a large quantity of hot water or soup? Do we not by such means stand a chance of inducing still greater debility, and of diluting and washing away that important secretion (already perhaps existing in deficient quantity) intended by nature to digest our food? But these are not the only evil consequences; substances, and particularly those of a stimulating nature, when in solution in a large quantity of water, are much more liable to escape the digestive process, and thus to get into the circulating system in their natural crude state, than when solid; the consequence of which is, that, the welfare of the animal economy requiring that they should be expelled as speedily as possible and the kidney being the natural outlet, this delicate organ is doomed to be stimulated with the unnatural matter; and when we reflect upon the constant state of irritation in which it must be kept by some individuals, we are astonished that its functions are not even more deranged than they appear to be.

the complaint, and will scarcely ever fail to prevent its terminating in serious consequences.

When these sediments are very pale coloured, and liable to be produced by the slightest causes, as trifling errors in diet, a chilly state of the atmosphere, &c. they commonly denote, as before stated, a feverish irritability of the system, bordering upon that which accompanies the phosphates. In this state they are more dangerous; and require a kind of treatment to be hereafter more particularly described, when we come to speak of the phosphatic diathesis, and particularly of those intermediate forms of disease which occur between the lithic and phosphatic diatheses.

Second and third varieties. The second variety of sediment does not necessarily, as was stated, indicate any specific disease, but is rather to be considered as a symptom of phlogistic fever, or very frequently of local inflammatory action. Of course the general treatment must correspond with this state of the system, while the particular treatment will depend upon the organ particularly affected. The same is true of the third variety; in which, though the character of the fever is different, various organs may be likewise affected. These circumstances of course render it difficult, as well as unnecessary, to be more particular, in this place, respecting the mode of treatment.

Crystallized sediments, or gravel. This is a

most important form of disease; and when habitual, and in great degree, will almost certainly, sooner or later, end in what is denominated a fit of the gravel. It is desirable, therefore, to counteract it as soon as possible, which is commonly a work of some difficulty, and requires, in the first place, perseverance and strict attention to the regimen formerly pointed out to be adopted in habitual amorphous sediments, of which it may be considered as another form: for though it does not necessarily indicate an excess of lithic acid in the urine, yet it very frequently is accompanied by it. In this form of the complaint, the use of alkalies is for the most part particularly indicated; but they are seldom or never to be given alone; but, to be really useful, must be conjoined with alteratives and purgatives. The pil. submur. hydrarg. comp. or a pill composed of the pil. hydrarg. and antimonial powder, taken at night, and followed up the next morning with a solution of Rochelle salts and carb. of soda in a bitter infusion, may be had recourse to. A little of the same mixture may be taken two or three times a day, so as to keep the bowels fairly open; or instead of this, a little magnesia may be taken in a glass of soda water, as often as it may be found necessary. This plan is to be persisted in for a considerable length of time, according to the severity and obstinacy of the symptoms; the alterative pill being gradually had recourse to at

longer intervals, and the doses of the other medicines diminished in a corresponding manner. If there be much irritation, recourse may be had to opium or rather hyosciamus. If acidity of the stomach and flatulence be present, the prussic acid may be given with great advantage. If gouty or other inflammatory action, the acetum colchici, &c. I wish it, however, to be particularly understood in this, as in all other instances, that I only attempt to lay down *principles* of practice: of course I do not intend the above plan to be strictly adhered to in all its details, which must be varied according to circumstances. Thus, a course of the Cheltenham waters may in most instances be advantageously had recourse to in combination with the alterative and alkaline plan. There may be cases, also, where purgatives, to such an extent as here recommended, may be improper. Indeed, I wish to observe, that in no instance they ought to be carried to excess, but should be so administered, in the outset of the disease, as to keep the bowels rather freely open, and no more, and as the disease recedes to ensure their natural operation.

I come now to consider the treatment to be adopted in the last and most severe stage of these affections, or what is usually denominated a *fit of the gravel.*

A fit of the gravel consists in the union of the second form of amorphous sediments with crystal-

line sediments. Hence there is indicated, as before stated, fever and inflammation, or both conjoined, with the secretion of a great excess of lithic acid. The principles of the treatment to be adopted, in this form of the disease, closely resemble those recommended in gravel, except that they must be more active. When the attack is acute, venesection or cupping from the region of the kidney, with active doses of calomel and antimonial powder, (or omitting the latter if nausea be present, and substituting opium or hyosciamus,) should be immediately had recourse to, and *precede the use of diuretic remedies.** When these have begun to operate sensibly upon the system, though, perhaps, before the purgatives have produced actual stools, the patient may have recourse to warm fomentations about the region of the kidneys, or, what is much better, the warm bath, and commence the use of the diuretic purgatives formerly mentioned, with the addition of the acet. colchici: and these means, if judiciously and vigorously applied, seldom fail of removing the inflammatory or spasmodic action of the kidney, and of producing a flow of urine. If the attack has been taken in time, the formation of a calculus in the kidney is thus certainly prevented;

* I have seen great mischief done by the incautious use of stimulating diuretics at the commencement of the attack. The sufferings of the patient have been all aggravated, and his life has been placed in extreme danger.

or at least what is formed will be very small, and scarcely ever fail to be brought away without producing those distressing symptoms which usually accompany the descent of a calculus down the ureter. It need scarcely be mentioned that a strict antiphlogistic regimen is to be adopted; and that the collateral and subsequent treatment must be regulated by the symptoms present, according to the judgment of the practitioner. After the more urgent symptoms have subsided, the patient should be warned of his danger, and be induced to submit to the regimen, &c. prescribed for gravel in the preceding pages. And if the case is very obstinate, or suspected to be accompanied by some local disease of the kidney, a large galbanum or other plaster may be applied to the lumbar region, or an issue or seton may be inserted in the neighbourhood of the kidney with great advantage.

CHAP. IV.

Of the Oxalate of Lime and Cystic Oxide Diatheses.

It is much to be regretted that so little is known respecting these forms of disease—a circumstance arising in some degree from various causes, but chiefly from their rarity. This is particularly the case with the cystic oxide, a very few instances only of which have hitherto fallen under the observation of medical men.

Of the oxalate of lime diathesis. Oxalate of lime very rarely, if ever, appears alone under the form of an amorphous sediment. It seems in some instances to be mixed with the lithic amorphous sediments in small quantity: but even this is by no means common. Its appearance is equally rare under the form of crystalline gravel. I have only seen one instance of this, and am able to refer to one more only.* The gravel was given to me for examination; but I am ignorant of the particulars of the case.

* See Scudamore on Gout, p. 166, third edit. The author speaks as if he had seen this form of gravel; but he does not describe the particulars of the case.

Mr. Brande states, also, that in this diathesis there is little or no sand or gravel voided. He gives a few particulars of one case where a mulberry calculus was afterwards extracted. The patient was a man "62 years of age, and about five years previously had suffered a slight attack of the symptoms of a stone passing from the kidney to the bladder. *He had voided no sand, and his urine always appeared clear*. During the last two years the symptoms of stone in the bladder attained such violence, as to render the operation necessary; and a very perfectly-formed mulberry calculus, about the size of a nutmeg, with a distinct oxalate of lime nucleus, was removed." *

I have seen three instances in which renal calculi of the oxalate of lime have been voided. One of these was from a gentleman subject to gout; but who otherwise enjoyed good health; and, what is singular, who never felt the least inconvenience from it, either when it descended from the kidney, or passed the urethra, though it was of very considerable size, and, like most of these calculi, very rough externally. The other two instances occurred in women, of whose health I can give no precise particulars, except that they appeared well when I saw them, which was several years after the stones had been passed from the bladder. This

* Royal Institution Journal, viii. p. 213.

accords with the remarks of Mr. Brande and Dr. Marcet, that these calculi occur at long intervals, leaving the intermediate health good.* It will, perhaps, appear presumptuous to make any further observations upon this diathesis, possessing, as we do, such imperfect data. I shall, however, venture to make a few remarks upon the subject, which I leave my readers, if they choose, to consider as *conjectural.*

1. We have seen that the oxalate of lime frequently forms renal calculi, which often increase to a considerable size in the bladder. From this I think we may infer, that the formation of this concretion is connected with *a distinct diathesis excluding the existence of other diatheses,* and that it is not an accidental occurrence happening in common with many others to the urine.

2. From the dissection of calculi, it appears that the oxalate of lime diathesis is both *preceded* and *followed* by the lithic acid diathesis—a circumstance which is peculiar to these two forms of deposite, and which, when taken in conjunction with the phenomena and circumstances already related, appears to show that they are *of the same general nature:* consequently it is probable that,

3. In this diathesis, instead of lithic acid, the

* On Calculous Disorders, p. 78, first ed.

oxalic acid is generated; which, by combining with the lime naturally existing in the urine, forms the concretions in question.

4. Is this oxalic acid actually secreted by the kidney, or is it formed afterwards by the action of the nitric acid upon some of the other constituents of the urine in the same manner that the purpurates appear to be formed? From various reasons which might be mentioned, the former opinion seems more probable.

From all these observations, taken together, I am induced to conclude that the oxalate of lime diathesis, though consisting in a manifestly deranged action of the kidney, and therefore distinct from the lithic acid diathesis, is nevertheless of the same general nature, and consequently that it requires a mode of treatment founded upon the same general principles.

Cystic oxide diathesis. The following is a summary of all we know respecting this rare species of calculus:

The first specimen, described by Dr. Wollaston, its discoverer, was taken from a boy five years old, and was covered with a loose coating of the phosphate of lime. This boy afterwards died from the formation of another stone, which consisted principally of the lithic acid, but was peculiar in

having its centre hollow, by the removal apparently of some more soluble substance of which the nucleus had consisted.* The second specimen was likewise described by Dr. Wollaston, and exists in the collection of Guy's Hospital. It was taken from a man 36 years of age, of whose case no particulars are recorded.

Soon after the above paper was written, Dr. Henry recognized two specimens of this variety of calculus in his collection; but with the histories of both he was unacquainted.†

The next case on record is described by Dr. Marcet, in his work.‡ It was removed from the bladder of a gentleman when about 20 years of age. This gentleman, both before and after the operation, passed several small calculi composed of the same substance, all of which had been distinctly traced from the kidney down the ureter by the usual symptoms. After the operation he had no symptoms of stone in the bladder; those descending into that organ having been discharged immediately. His general health was good, except when the calculus was passing down the ureter; though he was rather subject to be bilious or dyspeptic; but was never troubled with acidity.

* Philos. Trans, 1810, p. 223.

† Marcet, p. 82, first ed.; Henry, Med. Chirurg. Trans. x. p. 140.

‡ Loc. cit.

Latterly, it is stated that the fit of pain previous to the evacuation of calculi, which used to occur about once in six months, had become much milder; and that the hæmorrhage had ceased, though the evacuation of calculous matter in small quantities had been even more frequent than formerly—perhaps about once a month.

For the two next instances we are likewise indebted to Dr. Marcet. The first of these occurred in a gentleman 30 years of age, who had died with symptoms of renal calculi. On examination after death, a number of calculi were found in the kidneys, which proved to be of this variety. The second case was that of an elder brother of the same gentleman, who had died of a similar affection, and in whose kidneys calculi of a similar kind were found, accompanied by extensive disorganization of the kidneys and prostate gland. It may be worth while also to remark, that a third brother of the same family died with symptoms of calculi; but their nature was not ascertained.

The last two cases occurred to Mr. Brande, who has heard of no others. In one, the calculus was voided by a labourer; but no particulars were known of his case. In the other, several of these calculi, varying in size from a pin's head to that of a pea, had been voided at different times, during a period of thirty years, by a gentleman forty

years of age. He had been subject, from the age of six or seven years, to pain in the region of the loins, not confined to any particular spot, and seldom of any acuteness, or such as to prevent his ordinary occupations, which obliged him to lead rather a sedentary life. His usual state of health was good, his habits very regular, his diet ordinary and plain. He had used soda water, magnesia, and the alkalies, without any advantage. The further history of this case is unknown.*

All the specimens of cystic oxide calculi are remarkable for *their purity.* Hence it would appear, as Dr. Marcet has observed, that this diathesis has a more exclusive tendency in regard to the formation of other kinds of calculi, than the other species of urinary concretions. Nor does the diathesis seem to readily change into any other. In only one of the above cases it was followed by the phosphates, and in another, as is rendered probable, by the lithic acid.

We know nothing of the state of the urine in this diathesis, or whether the calculous matter is ever deposited in the form of gravel or other sediment; but the probability seems against this supposition. We know very little, also, respecting the state of the general health; though I think we may conclude that it is not much affected, and

* Royal Institution Journal, viii. p. 71.

that the cause of the disorder is rather a diseased or depraved action of the kidney.

With respect to the medical treatment of this diathesis, we are equally ignorant. If the above view be adopted, that it is of the same general nature as the lithic acid diathesis, the nature of the mode of treatment will be obvious from what has already been said; but this must be decided by future observation.

CHAP. V.

Of the Phosphatic or Earthy Diathesis.

As my observations have led me to conclusions respecting the deposition of the earthy phosphates, very different from what I believe are now prevalent among medical men, it becomes necessary for me to enter rather more into detail on this part of my subject than on some of the preceding ones; I shall, however, be as brief as possible.

The earthy phosphates, as has been before observed, appear in the urine under two distinct forms; viz. in an *amorphous* state; and, secondly, in the *crystallized* form.

I. Of amorphous sediments composed of the phosphates. These sediments consist invariably of a mixture of the phosphate of lime, and of the triple phosphate of magnesia and ammonia; but sometimes the phosphate of lime constitutes by far the greater proportion of them. Differences thus striking, in the composition of these sediments, indicate differences in the diseases in which they originate; but these are not, I think, of that

striking kind as to render it necessary to consider them under different heads: I shall, therefore, treat of them together.

A deposition of the earthy phosphates from the urine has been long observed to be attended by very distressing symptoms, though no one seems to have hitherto generalized them. They consist in great irritability of the system, and, derangement of the chylopoietic viscera in general; such as flatulence and nausea, obstinate costiveness, or peculiarly debilitating diarrhœa, or both frequently alternating; and the stools are extremely unnatural, being either nearly black, or clay-coloured, or sometimes like yeast. These are always accompanied by more or less of a sensation of pain, uneasiness, or weakness, in the back and loins. There is a sallow, haggard expression of countenance; and as the disease proceeds, symptoms somewhat analogous to those of diabetes, begin to appear, such as great languor and depression of spirits, coldness of the legs, complete anaphrodisia, and other symptoms of extreme debility: and the disease, if not speedily checked, seems capable of ending fatally. The urine in this form of disease is invariably pale coloured, and, upon the whole, voided in greater quantity than natural. Sometimes, (generally, I think, by day), it is voided in very profuse abundance; and in this case is of very low specific gravity; 1·001

or 1·002, for example.* At other times it is voided in less quantity, and its specific gravity is proportionally higher, but it is seldom very high; that is, surpassing 1·025. In the former case it is generally perfectly pellucid and colourless, and deposits no sediment; in the latter, it is sometimes opake when passed, and always after standing for a greater or less time, deposits a most copious precipitate of the mixed phosphates, in the state of an impalpable powder. In all cases the urine is extremely prone to decomposition, becomes alkaline by the evolution of ammonia, and emits a most disgusting smell. To those who have never seen this condition of the urine, the above will probably furnish but an imperfect idea. I trust, however, that the description will enable any one to distinguish such urine when they see it; and when they have once paid attention to its properties, they will afterwards readily recognize it.

With respect to the causes of this complaint, they may be either general or local; for the most part, however, they seem to partake of both characters.

* This is one of the forms of *diuresis*, in which the *increased* flow of urine is not *constant*, but takes place at certain times only, either spontaneously, or from the slightest exciting causes: so that, upon the whole, the quantity voided is generally greater (often much greater) than natural.

The greater proportion of those cases, which have come under my own observation, has been distinctly traced *to some injury of the back.* This injury has been of a character not very capable of being understood or described; but perhaps some idea of it may be acquired by my stating, that for the most part it has arisen from a fall from a horse, in which the person has received a violent general concussion of the spine, and often at the same time some local injury about the back, but not of such a nature as to confine him long, or to lead him to think that he has received any material injury;* and generally it has been quite forgotten till the patient's attention has been called to the subject. Among the general exciting causes may be also mentioned, severe and protracted debilitating passions, excessive

* I have never had an opportunity of inspecting a body after death under these circumstances: perhaps this would throw some light upon the subject. It is, I believe, a very old observation, that injuries of the back produce *alkaline urine*; yet what is surprising, no one seems to have thought of applying the remark to the present form of disease. This appears also to hold in other animals as well as man; thus, I have frequently observed jaded and worn out horses pass great quantities of lime in their urine; I have known the same also to take place in dogs, and particularly of the sporting kinds; and in both these instances have thought it probable, that the circumstance was connected with some strain or injury of the back produced by over exertion, or other causes.

fatigue, &c. The local causes are, generally some irritation about the bladder, or urethra, especially when operating constantly for a considerable length of time; as, for example, any foreign substance introduced into the bladder and producing irritation of that organ, including all sorts of calculi under certain circumstances; the retaining of a bougie or catheter in the urethra; strictures of the urethra in some rare cases, and in peculiar constitutions; all which, and many other similar causes, are capable of producing, in a greater or less degree, a condition of the urine more or less resembling that above described, and readily depositing the phosphates. Thus, it has been long known that any foreign substance introduced into the bladder almost invariably becomes incrusted with the phosphates, and not the lithic acid.*

* I cannot admit the explanation usually given of this circumstance to be generally true: namely, that under such circumstances, the urine in contact with the foreign substances always *undergoes an incipient process of decomposition;* if this were really the case, all sorts of calculi might be supposed to act as foreign substances, and ought to be immediately covered with the phosphates,—a circumstance in direct opposition to experience. The fact is, that the foreign substance sympathetically affects the kidney, and produces a change in the urine, causing it to abound in the phosphates, which are deposited on the foreign substance. Mr. Forbes has some excellent remarks on this point, which, as they exactly coincide with my views, by substituting *phosphates* for *concreting acid,* I shall quote: "In proper or healthy urine, there is

With respect to the proximate cause of this form of disease, we may suppose it to consist in a diminished or suspended action of the usual acidifying powers of the kidneys, and the formation, instead of lithic acid, of a greater quantity of alkaline matter than natural, as urea (equivalent to ammonia), lime, and magnesia; but this being little more than a simple expression of obvious facts, of course throws no light upon the immediate cause of these depraved actions.*

not in close vessels a particle of the phosphates deposited, the whole of them being in perfect solution," and "*to the end of time, there would not be calculus* from renewed applications of urine, in which the *phosphates* do not predominate:" when a foreign body gets into the bladder, if it meets not with the phosphates already redundant, it probably would *operate by irritation so as to occasion redundancy*." Hence, "a piece of bougie, if it were to get into the bladder of a person the state of whose urine is perfectly natural, it must operate to the production of different qualities in that fluid, before it can be incrusted. When the misfortune has occurred, *the urine has usually been before in a state too much adapted to incrustation*. The *diseases which require catheters and bougies, are almost uniformly accompanied by prevalence of the phosphates*, from the general and particular sympathies by which they are attended." Page 74, &c.

* I am aware, that it is the opinion of many eminent medical characters, that the inner coat of the bladder is the source of the earthy matter deposited by the urine on these occasions. I do not deny this altogether; and even think it possible, that in some instances the earthy matter may be partly derived from this source. On the other

The prognosis in this form of the disease will depend entirely upon its cause, and the length of time it has existed. If the cause be some injury of the spine, the prognosis will, for the most part, be exceedingly unfavourable. If the disease has been induced by local causes, as a calculus in the bladder, or any of the other circumstances mentioned, the prognosis will be more or less favourable, according to the less or greater duration of the diathesis, and its degree.

II. Of crystallized sediments composed of the phosphates. These are composed almost invariably of the triple phosphate of magnesia and ammonia, and exist in the form of perfectly white shining crystals.* This form of the disease sometimes occurs alone, but most frequently it alternates, or is accompanied with the variety of sediment previously described.

hand, I have seen cases, and one in particular, to be presently related, in which this earthy matter was deposited in greater abundance than I have ever seen it in any other instance. In this case, there was no calculus in the bladder; little more mucous deposite in the urine than natural; apparently no disease of the inner coats of the bladder; and, consequently, no other source of the earthy matter than the urine; the unnatural state of which secretion was quite enough to account for its presence.

* I have said, *almost invariably*; for, if I am not mistaken, I have once or twice seen a crystallized compound of the triple phosphate of magnesia and ammonia, and the phosphate of lime. These crystals were much larger than those of the triple phosphate, and less distinctly formed.

It seems, however, in general to be of a milder character than that producing the amorphous sediments, which it for the most part precedes. The constitutional symptoms in particular, accompanying it, being less severe than those above described, though evidently of the same nature. The urine also in this form of the disease is generally pale coloured, but not necessarily so much so as in the preceding; and upon standing for some time, an iridescent pellicle is frequently formed upon its surface, which, upon examination proves to be crystalline, and is composed chiefly of the salt in question. Minute crystals of the same salt are frequently attached to the sides of the vessel in which the urine has stood for a short time.* Urine abounding in this salt is often of considerable specific gravity, contains abundance of urea, and is very apt to become alkaline and putrescent. Sometimes, on the contrary, the specific gravity is lower than natural. When this salt abounds very much, the crystalline deposite is formed before the urine is discharged from the bladder, and consequently immediately subsides to the bottom of the vessel in which it is voided; most generally, however, it does not begin to form till the urine

* I have seen crystals of this salt, upwards of half an inch in length, in urine not remarkably unhealthy, which has been permitted to stand for a great length of time, and grow putrid. Such crystals cannot, I believe, be formed artificially.

has become cool, and sometimes not till it has begun to putrefy.

With respect to the causes of this form of deposite, they resemble, or may perhaps be identical in all respects, with those occasioning the preceding affection: they are, however, frequently much slighter in degree; thus any thing acting generally, and producing a *nervous state of the system*, such as the distressing passions, and particularly *mental anxiety* or *fear*, will frequently produce in many people an excess of this salt in the urine. The same is also true of many articles of food or medicine that produce a hurried secretion of the urine, and act as diuretics; as the neutral salts in some cases, and particularly the Rochelle salts, and other saline compounds in which the acid is of vegetable origin. It has been also stated, that a long continued use of alkaline remedies will likewise produce a tendency to an excess of this salt, as well as of the phosphates in general, and even lead to an actual deposition of them from the urine. I can readily suppose that this will be the case in some constitutions; but I have never pushed this class of medicines so far myself as to witness such effects. I wish it to be understood, that in general the slighter causes affect only the predisposed, and those in particular who are subject to other diseases of the urinary organs or urine. It may be also remarked, that children are more subject

to this form of deposite than adults—a circumstance, perhaps, to be referred to the greater irritability of the system at this age, and the great derangement of the digestive organs, to which they are subject.

The prognosis is, upon the whole, perhaps, more favourable in this than in the previous form of the disease. This, however, will entirely depend upon its cause and permanency. When it occurs but seldom, and from any of the minor circumstances above mentioned, it is usually only temporary, and of little importance. A very frequent recurrence, however, from the slightest causes, shows a tendency to the affection, which those who are liable to it would do well to look to, least it should become permanent, in which state it is not readily conquered.

Treatment. The indications of cure to be attended to in these forms of disease appear to be two: to diminish the unnatural irritability of the system; and to restore the state of the general health, and particularly of the urinary organs by tonic, and other appropriate remedies.

In severe cases of these affections, especially of the first class, opium, as far as my experience has hitherto extended, is the only remedy that can be employed with any advantage to fulfil the first indication. This must be given in large and repeated doses, such as from gr. i. to gr. v. or more,

two or three times a day. Under this plan the more distressing symptoms will commonly be speedily relieved; and now, in conjunction with the opium (in more moderate doses, if the state of the disease will permit) the mineral acids, cinchona, uva ursi, different preparations of iron, and other tonics may be had recourse to; or if the mineral acids should disagree, the citric acid may be taken instead. There may be also applied to the region of the loins, a large pitch, soap, or galbanum plaster, which frequently seems to afford considerable relief to the distressing pain there felt; or if the symptoms are unusually severe, and connected with manifest local injury, setons or issues may be instituted in the back. It was stated that the bowels are very often exceedingly irregular, and difficult to be managed, in this form of disease. Most frequently they are constipated; but purgatives especially of the more active class must be given with the utmost caution. I have seen, for example, the most serious consequences brought on by a small dose of calomel, which by inducing a diarrhœa, and consequent debility, has much aggravated all the symptoms, and endangered the life of the patient. Saline purgatives are also to be avoided; and recourse must be had to small doses of castor oil, or laxative injections. Mercury, if given at all, must be given in the smallest doses, and as an alterative only; but I am doubtful if the use of this remedy is not altogether

better omitted till the more distressing symptoms have somewhat yielded, and the patient has recovered a little strength. All remedies that act as diuretics should be carefully avoided, and the patient should be prohibited from drinking too much. Alkaline remedies must be most carefully avoided; their use, in every point of view, is most mischievous in this form of the disease. In less severe cases, and when the constitution is sound, and the strength not remarkably reduced, similar means may be had recourse to, though opium to the above extent is here seldom necessary or proper; in such cases also, occasional purgatives may be employed with safety and advantage; but even here, those of the milder class should be preferred, and which are not likely to excite the kidneys at the same time. In some of the diseases of children also, in which the triple phosphate in particular is copiously deposited, repeated purgative doses of calomel and rhubarb are of the utmost advantage. These diseases may be commonly distinguished by the absence of the severe symptoms above-mentioned, and by the high specific gravity of the urine.

In mild incipient cases, I have seen the greatest advantage from the combined use of the muriatic acid, hyosciamus, and uva ursi; conjoined with the use of alterative purgatives.

The *diet* in severe cases should be of the mildest

and most nutritious kind, and taken in very moderate quantities at a time. From what I have seen, I am certainly inclined to advise an animal diet in preference to an acescent vegetable diet, commonly recommended; but I wish it to be understood, that no positive directions are given on this point, which I leave to be determined by future observations, or rather, perhaps, by the circumstances of the patient; for I am disposed to believe, that in all instances, that diet is most proper for a patient, which agrees best with him, and which in many instances can be only known by actual trial; I may give it, however, as my opinion, that all watery diet, as soups, &c. should be taken very moderately. But these, and every thing else that can be done for a patient in this state, are of very little use, if the *mind* cannot be set at rest. The influence of mental anxiety is really astonishing in this disease; and absence from care, the exhilarating air of the country, and such exercises as are consistent with the patient's condition, will, perhaps, more than any thing else, contribute to the cure, particularly in the slighter cases, and when the cause is not local injury.

Severe cases of the first description have been almost always complicated with calculus in the bladder, and most of the distressing symptoms have in consequence been referred to that cause. To show, however, that such a disease really exists inde-

pendently of calculus in the bladder, I shall relate one or two cases illustrating this point.

Case 1. Aug. 14, 1820.—J. E. Joiner, aged 42, has been a sailor; and 19 years ago, when on board a ship, got a fall upon his back, which particularly affected the left side, about the region of the loins. This fall confined him three months on crutches; but he afterwards, as he supposed, got completely well; though every spring or summer since that period, he has always suffered more or less, and for a greater or less time, with pain in the loins. The present attack commenced 18 months ago in the usual manner, but with greater severity, and has continued more or less ever since. Till within these four months, however, he had not been led to observe any thing peculiar in his urine, but had been only annoyed with the usual painful symptoms and weakness in the back. At this time, the quantity of water began to increase very much; and he observed it to deposit occasionally a very large quantity of white earthy matter. Under these circumstances, he went to a dispensary, where his disease appears to have been considered as diabetes, and treated accordingly, but without any advantage. His symptoms at present are severe enervating pains in the region of the loins, extending round to the groin and lower part of the abdomen, and occasionally down the thighs and legs, accompanied by retraction and soreness

of the testes. Occasionally also he suffers excruciating pains in the head, affecting his sight. All these symptoms, however, are much worse on certain days than others, and the worst symptoms are usually accompanied by diarrhœa. Latterly he has become much thinner than usual; his appetite has fallen off; he sweats on the least exertion; and among other symptoms of debility, has complete anaphrodisia. He is thirsty, his tongue is clean and redder than usual, he is troubled with flatulence, and his bowels are very irregular. The state of his urine also is very variable: what he passes first in the morning, and perhaps once more in some other part of the day, is at first commonly transparent, and of a light yellow colour, but soon deposits a sort of mucous cloud, which in a few hours becomes converted into a perfectly white earthy matter. The specimen of the urine of this description which he brought with him, was contained in a two-ounce phial. Its specific gravity was 1·0234; and the earthy matter, when it was allowed to stand for some time, occupied nearly $\frac{1}{3}$ of the height of the bottle. It was in the form of a fine white powder, and was found to consist of the mixed phosphates. This urine reddened litmus paper; and contained a large proportion of urea, and fully the usual quantity of pale coloured lithic acid. At other periods of the day, and particularly during the morning, he is conscious of a sense of tightness or fulness of

the abdomen, from which he is relieved by voiding large quantities of a limpid colourless urine, nearly free from all sediment. I had likewise an opportunity of examining a specimen of this, and found it exactly resembling the first in its properties, except that it was much more watery, and its specific gravity was only 1·0064. The urine had a disagreeable smell, and was very prone to putrefaction, in which state the smell emitted was peculiarly offensive. It may be also observed, that it was passed without any difficulty, or urgent desire, except what arose from its quantity, which he supposed amounted in 24 hours to four or five quarts.

Ordered, *pil. sap. c. opio*, gr. v. *bis die.*

August 22. Found instant relief from pain after taking the pills; urine reduced to three quarts in 24 hours. States that the white sediment has nearly disappeared; complains of being very costive. On examining the urine voided yesterday morning, its specific gravity was found to be 1·0137, and there was only a slight deposite of the earthy phosphates; but its properties in other respects were nearly as before. The urine voided this day at six in the evening, was almost perfectly colourless and transparent, and had a specific gravity of only 1·0027.

Contr. pil. sap. c. opio, gr. v. ter die. Take to-morrow morning Ol Ricini. ℥i.

23. The castor oil affected the bowels moder-

ately, and afforded him some relief. Continues tolerably free from pain. The urine voided in my presence, at six o'clock in the evening, did not differ in appearance and specific gravity from *common water*, though it still emitted the same offensive smell as formerly in a less degree.

29. Felt better for three days after I last saw him, the urine had diminished in quantity, and the white deposite entirely disappeared. For the three last days the pain has returned, and the urine has increased in quantity. What was passed this morning had a specific gravity of 1·0242, and deposited a very copious mucous cloud, but no earthy sediment. The urea was excessive.

Ordered, *pil. sap. c. opio, gr. x. ter die.*

Sept. 2. Feels a great deal better. Little or no pain for the last three days. His urine deposits no white sediment, and he passes only a little of the clear urine in the forenoon, the whole amounting in 24 hours to 2 quarts. The specific gravity of what was passed this morning was 1·0201, and it contained an excess of urea. Has been costive for the last few days.

Contr. pil. sap. c. opio, gr. x. ter die. Take to-morrow morning Ol. Ricini ℥i.

12. Almost quite free from pain; and tried in consequence to resume his work, but was obliged to desist on account of a distressing sense of weakness in his back. His appetite is much improved;

he sweats less than usual, and is not sleepy. Rather costive. Urine reduced to two quarts in 24 hours; specific gravity of that voided in the morning 1·0174.

Ordered, *pil. sap. c. opio, gr. x. in the morning and at noon, and gr. xv. at bed time.* He was also ordered *to take to morrow morning, Ol. Ricini* ℥i. *and apply a large pitch plaster to the loins.*

September 19. Took the castor oil, which induced a diarrhœa that lasted for two or three days, during which time his pain returned. It was less severe, however, in the back than usual, and was accompanied by a peculiar sense of coldness and weakness in the calves of the legs. Has now recovered from the diarrhœa and all the other symptoms, and has not felt so well for many months. Urine in 24 hours about two quarts, and quite free from earthy sediment. Specific gravity of that voided this morning 1·0207.

Contr. pil. sap. c. opio, gr. x. ter die.

November 30, I saw this poor man again, and was happy to hear, that he had continued quite well from the last date, and had followed his work as usual, having taken the opiate pills occasionally. He had recovered his usual strength, &c. and his urine now abounded with the lithate of ammonia; but I suspect the presence of some organic disease, which will sooner or later prove fatal.

The only case on record that I am at present acquainted with equal to the above in severity, is one summarily described by Dr. Henry as follows :*—

Case 2. "Several years ago, the Rev. Mr. R——, of Cheadle, in Staffordshire, consulted me respecting a train of very distressing symptoms, some of which evidently denoted considerable disease in the kidneys. His urine, which at some times was perfectly limpid, was at others loaded with a white substance, which gave it, when first voided, the opacity of milk. On standing, a copious deposite took place, a portion of which was sent me for examination. It was perfectly white, and so impalpable as to resemble a chemical precipitate. On analysis, it proved to consist of nearly equal parts of the triple phosphate and phosphate of lime. The discharge of this powder was always preceded by violent attacks of sickness and vomiting; and its quantity was invariably increased whenever he took soda-water, or any other alkaline medicines. Besides the affection of the kidneys, there appeared to me to exist important disease of

* Med. Chirurg. Trans. x. p. 139. There are also two cases somewhat similar in Dr. Rollo's Treatise on Diabetes, p. 424, second edition. Both these cases were produced by *injuries of the back*, and were considered to be of a *diabetic* nature. The deposition of the phosphates is not indeed mentioned; but, as this is a symptom not constantly present in these affections, the circumstance might have been overlooked, particularly as the attention was otherwise directed.

the chylopoietic viscera; and to this I ascribe his death, which took place a few months afterwards. In this case it was remarkable that the weight of the body was reduced from 183 pounds to 100 pounds, at rather an early stage of the disease, without a corresponding degree of muscular emaciation." No one can doubt, I think, that this case differs from the preceding except in degree; and it is to be regretted that we know so little about it—particularly its cause.

Cases very analogous to the above also are alluded to by Mr. Brande, as occurring in persons returning from warm climates. The symptoms, according to him, are a white sabulous deposite in the urine, often going on to a great and alarming extent. There is pain in the region of the liver, sallow complexion, whitish brown and dry tongue. The bowels are irregular, sometimes tending to costiveness of an obstinate kind, sometimes succeeded by, or alternating with, relaxation, &c. These affections are stated to be much increased by the use of alkaline remedies, and to be best treated by vegetable acids, and particularly by a *generally acescent diet*. "To abstain from soda-water, and all alkalies; to refrain from malt liquor; to take weak lemonade and an occasional glass of cyder, as ordinary drink at meals. If accustomed to wine, to prefer Champagne and claret to Madeira or port; but to take little of either. If the bowels remain constipated, to take a drachm or

two drachms of Epsom salt in a half pint tumbler of lukewarm water in the morning fasting; or, what is more pleasant, to stir a tea-spoonful of magnesia into an occasional glass of sour lemonade. To eat salads and acid fruits, and more especially oranges, which, in this state of things, are an heroic remedy." * I have stated that the symptoms mentioned by Mr. Brande seem to point out some analogy between the diseases in question; but I must acknowledge that the treatment recommended by him is quite at variance with this opinion. I believe that the poor man whose case I have related would have speedily sunk under the above plan of treatment.

By way of illustrating slighter stages of this form of disease, I shall very briefly relate the two following cases:—

Case 3. A gentleman about 40, strong and robust, and apparently in good health, several years ago had a fall from his horse, and pitched upon his back. This gave him some pain and uneasiness at the time; but after a few days the whole subsided, and he thought no more of the circumstance. Very soon after this, however, and before he had well recovered, he was attacked with symptoms of stricture in the urethra, for which he was quite unable to account, as he had not for several years been in the way of contracting such an affection, nor had ever before been subject to it. This was

* Royal Institution Journal, vol. vi. p. 201.

attended by some irritation in passing his urine, and particularly the last portions of it; and the irritation remained for a greater or less time after he had voided it. He did not pay particular attention to the state of his urine at this time, and the symptoms by degrees gradually became less, though they never entirely subsided for any considerable time. Latterly he had been confined by a sedentary occupation more than usual, and they had returned with greater severity than ever; and he now remarked, for the first time, that the last portions of urine were loaded with a considerable quantity of white earthy matter, enveloped with mucus, the discharge of which was always accompanied by irritation in the urethra, about the seat of the supposed stricture, and which remained, as before, for a greater or less period after the act of passing urine. His general health was not much impaired; but he looked sallow, and felt dyspeptic. The urine was generally pale coloured and copious; and the earthy matter, on being examined, proved to be the mixed phosphates.

He was ordered the occasional use of an alterative laxative pill, and to take regularly, two or three times a day, more or less of a mixture composed of a strong infusion of uva ursi, tinct. of hyosciamus, and muriatic acid; and under this plan the symptoms entirely subsided in a few weeks. He was also directed, at the same time, to avoid every thing in the way of diet that disagreed with him,

or was obviously difficult of digestion: to take moderate exercise; but to carefully shun violent exercises, and all other circumstances tending to induce fatigue or debility; and he was warned that a protracted inattention to any of those points would certainly cause the disease to return.

Case 4. The following case I relate principally with the view of illustrating an opinion I have advanced, that the deposition of the phosphates is rather to be considered as indicating an increased secretion of earthy matter, than of the phosphoric acid.—The patient was a gentleman between thirty and forty years of age, who had for several years laboured under stricture of the urethra (acquired, I believe, in the usual manner), for which he had consulted an eminent surgeon, and obtained considerable relief. He never considered it, however, as entirely removed, and was in the habit of occasionally introducing a bougie himself. Latterly, the irritation had become greater than usual, especially at the moment of passing the last portions of urine, and for some time afterwards; and he now observed that he passed at this time a very considerable portion of white earthy matter, mixed with mucus. At length he voided one or two small calculi composed of the same earthy matter, which gave him the alarm, and induced him to apply for medical advice. His countenance was sallow and unhealthy, and the functions of

the digestive organs evidently deranged; but in other respects there was nothing remarkable. The earthy matter, and particularly the small calculi, consisted almost entirely of the *carbonate of lime*, mixed with a small proportion of the earthy phosphates. He was ordered an alterative pill composed of the pil. hydrarg. and ext. of gentian, and to take the muriatic acid three times a day. The acid, however, disagreed so much with him, that he was obliged to leave it off immediately. Nothing else was ordered; but he took a little respite from the fatigues of business, and went into the country, from whence he returned in the course of a few weeks, perfectly well, and has had no return of the affection since. It may be also remarked, that the symptoms of irritation in the urethra ascribed to the stricture subsided with the disappearance of the earthy matter.

In this case the secretion of lime without phosphoric acid was remarkable—even the absence of phosphoric acid in the usual proportion may, I think, be inferred; for if it had been present, it is difficult to conceive why it should not have combined with the lime. This case appears to be also interesting, inasmuch as it seems to show that a mere irritation in the urethra, in certain constitutions, and in certain states of the general health, will produce a tendency to the diseases in question.

It would be easy for me to multiply instances of

this description; but as these are sufficient to illustrate the subject, in conformity with my plan, I desist for the present.

Under the impression that they may be better understood, and at the same time, as a sort of *recapitulation* of what has been said, I have reserved for this place a few remarks upon those intermediate or *transition* states which usually exist for a greater or less time during the change from the different diatheses to the phosphates, or which sometimes precede the phosphatic diathesis.

Transition from the lithic to the phosphatic diathesis. The first circumstances in the condition of the urine which generally denote a change from the lithic acid to the phosphatic diathesis, are the general paleness of its colour, and sometimes its increased quantity. There is also, for the most part, a great tendency in the urine from the slightest causes to deposit the amorphous sediments, which are always of a pale colour, and generally contain more or less of the phosphates intermixed with them. As the tendency to change proceeds, the urine may be frequently observed, after standing a few hours, to be covered with an iridescent pellicle on its surface, which on examination is found to consist principally of the triple phosphate of magnesia and ammonia: and if at this time it be suffered to remain at rest for a

short time, especially in warm weather, it becomes putrid, assumes a yellowish opaque appearance, and will be frequently found to contain large spicular crystals of the triple phosphate above mentioned. This constitutes what may be considered as the *first* stage of the series of changes in question. I have once or twice known a calculus extracted from the bladder during this stage, which I have had an opportunity of examining; and in every instance found it externally composed of pale coloured lithate of ammonia nearly pure.

The above state of the urine frequently occurs in sickly children, in whom the functions of the digestive organs are much deranged. It is liable also to occur from all the causes formerly enumerated, and particularly in those of an irritable habit, and who are subject to lithic deposites in general: also from any cause deranging the general health, or producing local irritation in the urinary organs. As to the constitutional affections, they are always more or less of the irritable kind, and generally accompanied by derangements of the digestive organs. In adults, also, there is not unfrequently some uneasiness felt in the region of the kidney. With respect to the tendency and danger of this stage of change, it may be generally removed, or at least prevented from getting worse, by a judicious use of the means formerly mentioned, provided its exciting *causes* can be removed. But if

these are permitted to operate, or are of such a nature that their operation cannot be prevented, medicines are of very little use; and the phosphatic diathesis will certainly sooner or later be induced, particularly if there be already calculus in the bladder.

In the *second* stage of the change in question, the urine commonly assumes a more decidedly pale whey-like colour, and is either alkaline when voided, or very soon becomes so. The lithate of ammonia also diminishes in quantity, or entirely disappears; while that of the phosphates, and particularly the triple phosphate of magnesia and ammonia, is increased. In short, this stage runs into the confirmed phosphatic diathesis by such imperceptible grades, that it is frequently difficult or unnecessary to draw the line of distinction, the symptoms and treatment being the same in most instances, only differing, perhaps, a little in degree. It may, however, be proper to observe, that where the lithate of ammonia is deposited in large quantity, mixed with the phosphates, hyosciamus rather than opium is to be preferred, as opium seems frequently to increase the formation of the lithic acid.

Transition from the oxalate of lime to the phosphatic diathesis. In the second chapter of this section I have given a summary description of a calculus composed of a nucleus of oxalate of

lime surrounded by the phosphates, with an account of the series of intermediate changes which took place. From this description it appears that the first step towards the change in question was a secretion of an excess of lime; and that, as this proceeded, the proportion of oxalic acid decreased, while that of the phosphoric acid increased, until at length phosphate of lime, in nearly a pure state, was secreted, which constituted the external crust of the calculus. I had no opportunity of examining the urine in this case in the earlier stages of the affection; but in the latter stages it had all the properties, as might be expected, of that secretion when the phosphatic diathesis is present.

With respect to the treatment, &c. to be adopted in this form of the disease, I have nothing to add to what has been already advanced.

No instance in which a calculus of cystic oxide has been surrounded by the phosphates has come to my knowledge.

CHAP. VI.

On the Modes of Formation and future Increase of Calculi. On the Symptoms produced by the different Varieties in different Situations; and on the Medical Treatment to be adopted when they are lodged in different Situations.

I PURPOSE in this chapter to consider the subject of calculi in a *mechanical* point of view, or with reference to their origin and increase, and the symptoms they produce as solid foreign substances in the different urinary passages.

1. *On the formation of calculous nuclei.* The nuclei of calculi may be considered either as *primary or renal*, or *secondary or vesical*. Of these the formation of renal nuclei is by far the most important; the *secondary, or vesical* nuclei being almost always constituted either of small renal calculi which have descended from the kidney to the bladder, or of foreign substances introduced into that organ. The primary nuclei of calculi consist for the most part of lithic acid; occasionally of the oxalate of lime; more rarely of cystic oxide; and still, perhaps, more rarely of the phosphates. In some cases, also, coagulated blood, mucus, and

similar substances, have appeared to constitute the primary nucleus.

The greater frequency of primary nuclei composed of lithic acid is perhaps sufficiently accounted for by the fact formerly mentioned, viz. that the peculiar form of disease in which this principle exists in excess is by far of the most frequent occurrence; and is that which almost always precede other forms of calculus.

It has been already stated, that lithic acid nuclei are most liable to be formed in those whose urine ordinarily deposits this principle in the form of crystalline sediments or gravel, and at those periods of gout, fever, &c. when amorphous sediments are also liable to be formed, and when the watery portion of the urine is for the most part much diminished relatively to the saline and other ingredients. The truth of these remarks, I presume, must be so obvious, as to require no illustration: but it must be equally obvious that these cannot be the *only* circumstances connected with the formation of calculous nuclei; for if they were, these affections must be infinitely more frequent than they are, since the occurrence of such conditions of the urine as those above described are by no means uncommon. The fact is, that although the above conditions of the urine and health strongly pre-dispose, and are even necessary to the deposition of the nuclei, the presence of other circum-

stances are likewise necessary to their immediate formation. Some of these circumstances may be occasional and purely accidental; but, generally, it is probable that they are the result of disease, and somewhat analogous to the following:

The kidney is made up of a congeries of similar parts, or little kidneys, if we may use the expression, each one of which is independent of the others, in its structure, and may therefore, probably, independently of the others, become more or less deranged in its functions. Let us suppose one or more of those little kidneys similarly deranged to the others, but in a greater degree, so as to secrete very little water, but a large proportion of lithic acid. In such a case the lithic acid must be obviously supposed to exist in that peculiar semi-fluid condition, or state of hydrate,* which it is well known to be readily capable of

* Lithic acid is well known to be capable of existing in a sort of semi-fluid state, or as a *hydrate*, for some time before it undergoes the process of crystallization. This may be illustrated by dissolving a little of this principle in an alkaline solution, and precipitating it, when cold, by the addition of muriatic acid. The lithic acid separates in the form of a bulky gelatinous mass, which after a greater or less time begins to diminish rapidly in bulk, and at the same time to assume the crystalline form. The lithate of ammonia voided by birds, serpents, &c. and the lithate of soda formed in the human subject during gout, when first secreted, exist

assuming. In this state it is bulky, and may thus occupy the whole of the infundibulum in which it has been deposited; or the quantity may be supposed to be sometimes so great as to be partly protruded, in a similar state, into the common receptacle or pelvis of the kidney. After remaining in this state for a greater or less time, crystallization may be supposed to take place; the semi-fluid mass is now much diminished in bulk, and perhaps reduced to the form of a congeries of crystals easily separable from one another, and thus passes off in the form of gravel; or, what may easily be supposed to take place, (especially when the lithic acid is very impure, and combined with a larger proportion of other matters than usual,) it may assume the form of an imperfectly crystallized or amorphous mass, and thus constitute a nucleus possessing these characters; or something between these two extremes may take place—the plastic mass may separate partly into crystals, and partly remain an amorphous mass, enveloping those crys-

in this semi-fluid or plastic state, and afterwards become hard, apparently by undergoing an imperfect kind of crystallization, by which they are separated from the water with which they were combined, and held in imperfect solution. I have repeatedly seen both the lithic acid and lithate of ammonia deposited in the urine in this state of hydrate under the form of a gelatinous mass, having much the appearance of mucus, for which I at first mistook it.

tals; in which case a mixed kind of nucleus will be formed.*

I have hazarded the above explanation of the origin of lithic renal calculi, because it appears to me to throw considerable light on their formation and general history. It was suggested partly by a careful consideration of the symptoms attending their formation, and partly by the phenomena they present on dissection; both of which have been already detailed.

I have had few opportunities of examining renal calculi composed of the oxalate of lime, from their being comparatively much more rare. Sometimes they are formed on a primary nucleus of lithic acid. In one or two instances I have seen them contain in their centre an irregular cavity, formed apparently by the agglutination of several imperfectly globular-shaped plastic masses round a substance which had subsequently been entirely removed or had disappeared by drying; the whole being afterwards surrounded by concentric laminæ

* Since the above was written, an opinion somewhat similar to the above on the formation of renal calculi of lithic acid, has been advanced by Mr. Earle. This gentleman, like myself, refers the occasional origin of such calculi to some organic disease of the kidney, or parts connected with it, by which it is rendered incapable of performing its customary function of separating water, but still retains the power of secreting lithic acid. Med. Chirurg. Trans. xi. 211.

of the same substance. It may, perhaps, appear difficult to conceive how a substance so insoluble as oxalate of lime can exist in a plastic state, or form a calculus at all; since, in our hands, this salt occurs only in the state of a powder, and seems incapable of concreting or assuming the crystalline form. Perhaps the circumstance may admit of an explanation, by supposing that a solution of oxalic acid nearly in a saturated state, and perhaps in union with a little lime, is secreted by a portion of one of the kidneys instead of the lithic acid in the former case; that this, enveloped in the usual animal matters, passes from the infundibulum into the pelvis of the kidney, and there meeting with the lime naturally contained in the urine secreted by the other parts of the kidney, instantly combines with it, and forms the compound in question; and that from the peculiar manner in which it is formed, and the abundance of animal matters present, it may be able to exist for some time at the temperature of the human body, in a plastic semi-fluid state, before the whole concretes into a solid mass. Whether this explanation be admitted or not, which is a matter of no importance, the facts are certain, that oxalate of lime not only does sometimes exist as an amorphous mass in renal calculi, but occasionally in the form of crystals also—a circumstance still more

difficult to account for, except on some such supposition as the above.*

Calculi of cystic oxide are extremely rare. From what has been already quoted on this subject, there is reason to conclude that they generally originate in the kidneys. I have only had an opportunity of examining the primary nucleus of one specimen of this species of calculus: it consisted of a small triangular amorphous mass, apparently of the same matter as the rest of the calculus, though a little deeper coloured. From the peculiar nature of this species of calculus, there is, perhaps, little difficulty in supposing that it can readily exist in the state of hydrate; and, consequently, that it may probably be secreted in a plastic state.

Nephritic calculi composed of the phosphates certainly exist; though they are very rare. This probably depends upon various circumstances.— In the first place, this form of the disease is seldom original, but consequent to others; and the system appears to be affected *generally*, rather than the kidney locally, as in the other forms of the dis-

* Dr. Marcet states that he has seen three specimens of mulberry calculi passed by different people, having a distinct crystalline texture. *On Calculous Complaints, first ed.* p. 78. I have elsewhere stated that I have seen in one instance distinct crystalline gravel in pretty large crystals composed of this salt.

case. In the second place, the large flow of urine, and the consequent hurried state of action to which the kidneys are necessarily subject, may be justly considered as unfavourable to the formation of renal calculi. In some instances, however, as before stated, calculi composed of the phosphates actually do form in the kidney; but in every instance of this description, the particulars of which I can trace, it has occurred only in very severe and obstinate cases of the phosphatic diathesis; and in the only case in which it has occurred to myself, it took place in a gentleman, who suffered the most excruciating agonies, from the existence of a calculus in the bladder composed of the phosphates.

Of the symptoms produced by renal calculi. The symptoms produced by the presence of calculi in the kidney are often exceedingly obscure; and to enable us to form an accurate opinion upon the subject, a minute inquiry into the patient's previous history is commonly requisite. It is, however, astonishing to what extent disorganization will sometimes proceed in this form of the disease, without producing any very distressing symptoms, or even scarcely any symptoms at all. For cases of this description, I refer to Dr. Marcet's work on Calculous Complaints.* And in all instances it is probable that when the calculus is of moderate size,

* Page 1.

it produces very little uneasiness. When, however, a calculus has become too large to descend into the bladder, and is permitted to go on increasing, suppuration and gradual wasting of the kidney necessarily take place. This is generally accompanied by a long-continued sense of weight or pain in the lumbar region more or less acute, which is commonly much increased by exercise, particularly riding on horse-back, or in a rough carriage. There is also occasionally retraction of the testes, and a sense of numbness extending down the inside of the thighs. Not unfrequently, also, the urine is rendered bloody or purulent by a discharge of these fluids from the diseased organ; and, moreover, is generally loaded with amorphous sediments or gravel, particularly if the prevalent diathesis be of the lithic kind.

Such are the most common symptoms attending a retention of a calculus in the kidney, which but too frequently terminate only with the life of the patient. Notwithstanding this, however, for the reasons above mentioned, the general prognosis is by no means so unfavourable as might be expected: not that the disease can be cured; but that a person may exist for a great number of years with this affection, without being a remarkable sufferer, and may at last die from other causes.

In general, however, this form of the disease takes a different turn. The calculus, while yet of

moderate size, quits the pelvis of the kidney, and enters the ureter. This is almost always indicated by a sudden attack of very acute pain in the region of the kidney, accompanied by violent sickness and vomiting. The pain in the back commonly extends to the groin and down the inner part of the thigh of the same side. The urine is at the same time high coloured, small in quantity, and often mixed with blood. These distressing symptoms last for a greater or less time, and at length in favourable cases terminate as suddenly as they began, the moment the calculus quits the ureter, and enters the bladder. There are, however, instances on record when calculi of very considerable size have passed down the ureter without producing severe symptoms, and even without the consciousness of the patient; but such cases are rare.

The sudden cessation of the pain, and other symptoms above described, indicate, as has been seen, the arrival of the little calculus into the bladder, from which it is sometimes voided instantly without any trouble; but most commonly, it is retained; when recourse must be had to the plan of treatment to be presently described.

In some unfortunate cases, the calculus becomes permanently retained in the contracted portion of the ureter; thus producing a long train of symptoms more or less resembling those above related,

and which generally end in the disorganizement of the kidney, &c. and finally the death of the patient.

Treatment of renal calculi. When the presence of the symptoms described in a former part of this volume, taken in connection with the above, have rendered it probable, that a calculus has been recently formed, and exists in the kidney, our attention should obviously be directed to the removal of it, if possible. This is commonly best effected by purgative doses of calomel, connected with the use of the warm bath, or hot fomentations to the region of the kidneys. The calomel may be immediately followed, or accompanied, by the use of hyosciamus in pretty large doses, so as to ensure its antispasmodic effects on the system; and the purgative effects of the calomel may be increased or kept up by the use of some of the diuretic purgatives, such as the neutral salts, and particularly the tartarized soda. This plan may be pursued for a greater or less time, according to the circumstances of the patient; and will, in favourable cases, be followed by the expulsion of the calculus from the kidney, without those very severe symptoms above described as commonly accompanying its descent down the ureter. Sometimes, however, these urgent symptoms take place, when similar means should be persisted in, with the addition, if they are very severe, of copious topical blood-

letting from the loins. The only variation necessary, if any, is perhaps, in obstinate cases, to be more careful in the exhibition of diuretic purgatives, to give the hyosciamus (or opium, in some cases) in still larger doses, and to follow up the local bleeding by the immediate use of the warm bath, which may be persisted in even to fainting: and the judicious application of those combined means seldom fail to produce the desired effect.

When, in spite of all these remedies, the calculus still remains in the kidney or ureter, or when, from the length of time the disease has existed, or from other circumstances, its expulsion appears hopeless, recourse can be only had to preventitives and palliatives. Thus, if in the kidney, we may still hope to prevent its future enlargement, by a careful attention to all those circumstances formerly pointed out, as having a tendency to increase the deposition of the different varieties of calculi; in addition to which, the introduction of a seton or issue, near the part affected, may be recommended; the good effects of which, as pointed out by Mr. Earle, cannot be disputed.* In such cases the urine may pass, in part at least, as usual; but those cases appear most hopeless, when the calculus has lodged in the ureter, and where the passage of the urine is liable to be completely

* Med. Chirurg. Trans. xi. p. 211.

stopped; and under these circumstances, instances are on record where the canal has been expanded to an enormous size. In such cases we can scarcely hope for advantage from any mode of treatment.

The arrival of the little calculus into the bladder, constitutes a most important period in the history of these affections; as, on the treatment then adopted, its expulsion or retention will in many instances entirely depend. Sometimes it is immediately expelled from the bladder by the urethra, particularly if means similar to those above recommended have been resorted to; but frequently it is retained for the present; and at length, after a greater or less interval, when the irritation of the parts has subsided a little, it comes away in favourable cases when it was least expected. These circumstances lead to a plan of treatment somewhat different from those commonly recommended, and which I have seen eminently successful.

This plan is similar in its principles to that above related for expelling the calculus from the kidney, and is moreover partly founded on the obvious assumption, that whatever can pass down the ureter will pass by the urethra, provided that canal be in its natural state. Hence, the principles of treatment are very simple, and consist in nothing more than in attempting to allay by antispasmodics, and particularly by hyosciamus, that

irritable state of the urinary organs, and especially of the sphincter vesicæ, which seems to exist under these circumstances, and to prevent the calculus from entering the urethra; and afterwards, or rather at the same time, to favour the expulsion of the calculus, by exhibiting diuretic purgatives, with the view of exciting an increased flow of urine. By this plan I have seen calculi removed from the bladder in a few hours, which had been apparently retained there for several months, and in one instance, beyond a doubt, as long as *five* months.

Of the origin and future increase of vesical calculi. The most frequent cause of vesical calculi, as before stated, is the retention of a renal calculus in the bladder, where it constitutes what we have termed a *secondary* nucleus, round which the further accretion of calculous matter takes place. Sometimes, though much more rarely, this nucleus consists of a clot of blood, or hardened mucus; sometimes of a foreign substance introduced into the bladder, &c.

As to the future increase of vesical calculi, this, like their origin, is well understood: it being sufficiently obvious, that it can arise only from the gradual precipitation of that excess of the insoluble principles of the urine which cannot be retained in solution in that fluid. There are, however, some trifling varieties in the modes in which this precipitation takes place in the different

species of calculus, which will be mentioned after we have considered the general nature of the supersaturated state of the urine alluded to.

Saturation in a saline solution of a constant temperature may be defined to be the point at which the solvent, always in contact with the salt, can neither take up any more, nor let go any more. Hence, every saline solution which precipitates a salt without any change of temperature, obviously contains more of that salt than is necessary to saturate it, or, such a solution is said to be supersaturated.

The point of *supersaturation* is unfixed, and depends upon many extraneous causes; but the point of *saturation*, although it for the most part varies with the temperature, is supposed to be as fixed and constant, at any given temperature, as that of the freezing or boiling of water. Hence, in a supersaturated solution, the excess is always sooner or later deposited, and the solution arrives at the point of *saturation*.*

Let us apply these remarks to the subject in question. A calculus in the bladder may be considered as a substance placed in a solution of various principles in a certain quantity of water. If any of the more insoluble of these principles

* See M. Gay Lussac, Ann. de Chimie, et de Physique, xi. 296; Annals of Philosophy, xv. 1.

exist in this solution in a state of *supersaturation,* the calculus will afford a nucleus round which the *excess* will be deposited. But if none exist in a state of excess, of course none can be deposited, and the calculus will not increase in bulk.

Such is the general nature of the increase of urinary calculi in the bladder; but a great deal of additional light is thrown on this subject, by a careful attention to the structure of urinary calculi. Thus, some of them have a crystallized texture, indicating purity; others, exhibit an amorphous or earthy fracture, indicating for the most part impurity or mixture: while the general structure of almost all of them is laminated, indicating, as we shall attempt to show, that their formation has been interrupted, or has taken place at distant intervals. This is particularly the case with calculi composed of lithic acid, which constitutes the most frequent species.

The following are some of the reasons which appear to me to show, that calculi are formed at distant periods, and that their laminated structure can only be explained on this supposition.

There are innumerable cases on record, where calculi have been known to exist in the bladder for a great number of years, without attaining any very extraordinary magnitude. That such calculi were *constantly* increasing for such a length of time, is very difficult to conceive, for obvious

reasons; and the difficulty is much increased when we take into account the well-known fact, that the urine of the same person differs exceedingly in its degree of saline impregnation at different times. Further, if a calculus was constantly increasing, its texture should be homogeneous. But they are *laminated;* and this laminated structure, while it is thus in direct opposition to the opinion of their being constantly on the increase, is just what might be expected to take place on the opposite supposition, that they are formed at different periods, separated by longer or shorter intervals. Thus, during these intervals of interruption in the formation of a calculus, its surface may be naturally supposed to become *water-worn,* and less apt for future accretion. Hence, when a tendency to deposition returns, it will have to commence *de novo*, and as it were upon the surface of a foreign body; the consequence will be, that the adhesion between the old and the new coats will be less firm than in the intermediate parts, and that a calculus, thus formed, will be disposed, when broken, to separate into concentric laminæ, like the coats of an onion.

General symptoms produced by the presence of calculi in the bladder. Dr. Marcet sums up the general mechanical symptoms produced by calculus in the bladder, in the following words: "An uneasy sensation is felt at the

extremity of the penis, which often amounts to actual pain; but this is only perceived (at least during the first period of the disorder) on making some violent effort, or upon a sudden change of posture, or immediately after expelling the last drops of urine. The pain, however, gradually becomes more constant and more severe; the desire to pass urine becomes more and more frequent, and it can at last be discharged but in small quantities at a time, or even drop by drop. It often happens, that the urine, when flowing in a full stream, and without any pain, suddenly stops, even when a considerable quantity of it remains in the bladder, and when consequently the desire of voiding it is still urgent. But it is also frequently observed, that the pain and difficulty are not felt until only a few drops of urine remain in the bladder; when this organ, being no longer defended by the interposed fluid, the pressure of the stone is much more generally felt. This pain, and sudden interruption, are considered, by Sir James Earle, as almost certain diagnostics of the disease. They are usually occasioned by the weight of the stone pressing against the neck of the bladder; the pressure, therefore, naturally made by the patient seldom answers any useful purpose. Nothing, in fact, can remove the obstacle, but an alteration in the situation of the stone; and this is more readily effected by the patient changing the posture of his

body, so as to prevent the stone from gravitating towards the neck of the bladder, than by any pressure the patient can make, with a view to expel its contents. Some instances, indeed, are recorded, in which the stone having acquired an enormous size, the patients, in order to evacuate their urine, were literally obliged to stand on their head, almost in a vertical position."*

Such are the mechanical symptoms usually produced by a stone in the bladder; to which may be added, the occurrence of bloody urine after exercise, spasmodic stricture of the urethra, the most distressing tenesmus, and occasionally severe pain and retraction of the testes, accompanied by a numbness, extending down the inside of the thigh, even to the bottom of the foot in some instances. Indeed, in every severe case of stone, and particularly of the phosphates, that has hitherto fallen under my observation, I have constantly found some peculiar sensation referred to the hollow part of the bottom of the foot. This has in some instances amounted to pain, as severe and harassing as what was felt in the bladder; at other times, it has been only a slight sense of numbness; and in one case it assumed the form of a troublesome and almost constant itching.

These symptoms go on increasing for a period

* On Calculous Disorders, page 15, first edition.

more or less considerable; when at length the patient's health gives way, and the diathesis, whatever it might have been before, changes to the phosphatic, and the coats of the bladder becoming diseased and thickened, the more distressing symptoms are aggravated in a tenfold degree, and death at last closes the scene of misery.

In some instances the calculi become enveloped in folds or cysts, formed of the coats of the bladder; in this case they often produce little inconvenience, and the symptoms, if any, are always more or less obscure. Many instances of such cases are recorded by different authors, and by Dr. Marcet among others, to whose work I refer.

Having thus detailed the symptoms produced by calculi in general, I come now to consider a little more closely the characteristic symptoms usually attending each species of calculus: and, first,

Of lithic acid calculi. The symptoms produced by lithic acid calculi are, in general, of a milder and less formidable nature, than those produced by any other species. Many instances are on record where these calculi have been found in the bladder after death, the existence of which was never suspected during the life of the person; a circumstance, I believe, which can scarcely be said of any other species except when encysted: I shall not take

up the time of my readers by referring to instances of this kind, which I presume must be familiar to every one who has attended to the subject, but shall simply state that I am in the habit of occasionally seeing a gentleman who was ascertained, by sounding, to have calculus in the bladder several years ago; but who, for the last three years, has suffered so little from it, as for weeks together to be almost unconscious of its existence. I knew also another instance where no less than four renal calculi of this species unquestionably existed in the bladder for five months, without producing any symptom whatever, except towards the end of the period a little irritation about the neck of the bladder, which caused their existence to be suspected, and led to the adoption of the necessary means for their expulsion. One of them was nearly an inch in length.

The urine, in this form of calculus, is always of the natural colour, more or less deep. Its specific gravity is higher than that of health; and it almost always deposits crystallized sediments on cooling, which are commonly much increased at certain periods when the pain and irritation are worse than common; at these times also the crystallized sediments are not unfrequently accompanied by amorphous sediments, and much mucus. The mucus, however, is by no means ordinarily so abundant in this species of calculus as in some others; and the urine, which is sometimes a little turbid at first,

commonly becomes, after standing some time, perfectly transparent.

Oxalate of lime and cystic oxide calculi. The symptoms attending the mulberry calculus are commonly well marked and severe. I have had, as before observed, little satisfactory opportunity of witnessing this diathesis, and cannot therefore at present venture to state any *positive* characteristic of it; but the *negative* proofs of its existence, I presume, must be sufficiently striking. If all the symptoms of calculus be present, and particularly if a stone be actually known to exist in the bladder, and if the urine be clear, and deposits neither lithic acid nor the phosphates, there is ground for a fair presumption that the calculus present is either composed of the oxalate of lime or of the cystic oxide. And if no small calculi have ever been voided, we may almost certainly conclude from this circumstance, and the more frequent occurrence of the mulberry species, that the calculus is composed of the oxalate of lime; as it would seem that those subject to the cystic oxide diathesis frequently void small fragments of that substance.

Calculus composed of the phosphates. Calculi composed of the phosphates cannot, I presume, exist in the bladder for any length of time without producing, in the most decided manner, all the symptoms of calculi. The agony produced by the presence of this species of calculi in the bladder, far surpasses any thing I have ever witnessed from

any other species. Not only are the local symptoms severe beyond measure, but the whole constitution seems to suffer in a striking manner; so that those who have been accustomed to see much of these complaints can almost tell even from the *looks* of a patient, that he is labouring under this form of the disease. An idea of the constitutional symptoms may be acquired from what has been before stated, when the different diatheses were treated of; and if we suppose the symptoms there detailed to be aggravated in a tenfold degree by all the local agonies of stone in its worst form, we shall obtain a faint idea of the sufferings of those poor wretches who are doomed to this species of calculus.

The urine in this form of the disease is so characteristic, that it cannot be mistaken for a moment. It is generally voided in considerable quantity, and is of a pale whey colour, and slightly opake. Its specific gravity is low, and usually varies between 1·006 and 1·012. It commonly deposits the phosphates in abundance, intermixed with a large quantity of a peculiar mucus, having a very characteristic appearance, but which is not easily described. It soon becomes alkaline, and undergoes the putrefactive process; and in this state emits a most offensive smell; and these changes take place so rapidly, that in severe cases it is difficult to keep a room sweet when a patient is confined with

this affection. In short, the circumstances connected with this form of calculus are all so striking, that in the great majority of cases, they must, I think, be sufficiently obvious even to the most superficial observers.

Treatment to be adopted in the different species of calculi. The treatment to be adopted in calculous affections is either of a local or general description. The local treatment is nearly the same in all the species; the general treatment will depend upon the nature of the calculous diathesis.

The local treatment of calculi will obviously consist in little more than the exhibition of anodynes in some form or other. Hyosciamus and opium, either alone or combined with astringents, in some cases, as with the uva ursi for example, may be given internally. When thus exhibited, the hyosciamus is in general to be preferred in the lithic acid diathesis, and opium in the phosphatic. I have, however, seen striking temporary relief produced, even in cases of phosphatic calculus, by large doses of hyosciamus combined with the uva ursi. Opium may be also employed in the form of suppository, injection, embrocation, &c. but the form of suppository is perhaps the most beneficial, as well as preferable in other respects. In conjunction with opiates, or, where they cannot be used, the warm bath, fomentations,

sitting over hot water, and all the well-known similar means, may be had recourse to.

Lithic acid calculus. As far as I have hitherto remarked, the distressing symptoms produced by this species of calculus, as is indeed more or less true with all the others, have a very constant relation to the severity of the diathesis present. That is to say, in proportion as the urine is unnatural and loaded with gravel and amorphous sediments, in the same proportion are the patient's sufferings. Hence our first object should be to restore the urine to its natural state. To accomplish this, the means formerly recommended should be had recourse to, in conjunction, if necessary, with the local employment of anodynes in the way above-mentioned. Perhaps, however, it may not be deemed superfluous if I briefly recapitulate these means. We shall suppose the diathesis distinctly present, that the urine is high coloured, of great specific gravity, and loaded with amorphous and crystalline sediments, &c. The first means to be recommended, in ordinary cases, is usually a dose of calomel and antimonial powder—the Plummer's pill or some other alterative purgative, taken at night, to be followed up the next morning by an alkaline diuretic purgative, composed, for example, of a mixture of Rochelle salts and magnesia, or subcarbonate of soda: during the day a strong infusion of uva

ursi, combined with hyosciamus and the liq. potassæ, &c. may be taken. These means are to be persisted in for a greater or less time, according to the circumstances, and till the urine begins to get natural; it may then be gradually left off, or varied, as occasion may require; and under this plan it will be found that, in the majority of cases, not only the urine will assume its natural state, but most, or all the distressing symptoms of calculus in the bladder, will be very much diminished, and in many instances disappear. It is obvious, also, that while the urine is in its natural state, the calculus cannot increase in size.

After the diathesis is once fairly broken by these means, it may in general be easily prevented from recurring by attention to the diet, and other circumstances formerly mentioned as inducing this diathesis, and by the occasional use of medicines; and the patient will scarcely know that he has calculus in the bladder, at least from the pain that it gives him. I state this with confidence; but, at the same time, I wish to be understood to mean, that the freedom from pain, &c. depend in no inconsiderable degree upon the size of the calculus, its smoothness, upon the exercise a patient is obliged to take, &c. all of which are presumed to be favourable; for it must be sufficiently obvious that a foreign substance in the bladder cannot be prevented from acting *mechanically*, and from oc-

casionally producing bloody urine, or a temporary stoppage of the discharge of that secretion from the bladder, and similar symptoms, especially if the patient is obliged to take severe exercise.

Lithate of ammonia calculus. If this calculus, from the state of the urine and symptoms, be supposed present, recourse must be had to the means recommended to be adopted in the phosphatic diathesis, and alkaline remedies must be carefully avoided. I doubt very much, however, if any treatment will prevent, under these circumstances, the phosphatic diathesis from being sooner or later established.

Oxalate of lime and cystic oxide calculi. Besides the local and general use of anodynes, attempts must be made in these, as in the last diathesis, to restore the urine, if possible to its natural state, but with respect to the means to be adopted with this view, I have nothing at present to add to what I have formerly mentioned.

Calculus composed of the phosphates. It should be our object, as in all other affections of this description, to restore the urine as speedily as possible to its natural state. I am sorry, however, to be obliged to confess that I have never been able to accomplish this purpose in a single instance, even after the most fair and persevering trial of almost every remedy that has hitherto been recommended, or that I could devise as likely to effect my purpose. The consequence has been, that I have never been able

to procure more than a temporary relief from suffering by the various exhibition of opiates, &c. The operation of lithotomy, therefore, seems to be the only alternative in this form of the disease. If, however, the case is doubtful, or the patient refuses it, or his situation will not admit of the performance of the operation, recourse may be had to the means formerly pointed out when the nature of this diathesis was treated of in detail.

In concluding this part of my subject, I cannot too strongly impress upon my readers the necessity of frequently examining the state of the urine. Those who wish to know any thing respecting the deranged operation of the urinary organs must submit to this drudgery, or be content to remain ignorant. There is no alternative. Patients should be also directed to make general observations upon this subject themselves. In particular, they should be directed to keep two or three large wine or ale glasses in their bed room, and observe the state of the urine at different times of the day, especially in the morning and evening, and likewise to note the changes which it undergoes by standing for some time; for which purpose, the different specimens should be permitted to remain in the glasses for at least twenty-four hours.

CHAP. VII.

General Observations on the Periods of Life, Sex, Climate, &c. most subject to Calculous Affections. On the Mortality attending the Operation of Lithotomy; with Observations on the Circumstances in which it ought or ought not to be recommended.

FOR the following data respecting the periods of life most subject to calculous affections, and similar circumstances, I am indebted to preceding authors, and particularly to Dr. Marcet and Mr. Smith,* whose works have been already so often referred to.

The first table is taken from Mr. Smith's valuable paper, and represents the number of cases of operation for stone, at all ages, which have occurred at the Bristol Infirmary:

* Mr. Smith's paper was published after most of the present volume was written; but for the sake of incorporating the valuable data it contained, the second chapter of this section was partly remodelled.

												Consisting of		
												Males.	Females.	Total.
Under 10 years.	Age.	1	2	3	4	5	6	7	8	9	10			
	Cases.	0	1*	17	22	20	14	17	7	25	13	134	2	136
Between 10 and 20.	Age.	11	12	13	14	15	16	17	18	19	20			
	Cases.	11	16	10	5	4	5	2	5	5	2	62	3	65
Between 20 and 30.	Age.	21	22	23	24	25	26	27	28	29	30			
	Cases.	7	3	1	4	4	2	4	2	4	4	34	1	35
Between 30 and 40.	Age.	31	32	33	34	35	36	37	38	39	40			
	Cases.	4	4	3	1	3	5	4	4	3	3	33	1	34
Between 40 and 50.	Age.	41	42	43	44	45	46	47	48	49	50			
	Cases.	4	3	4	4	4	3	2	3	2	8	37	0	37
Between 50 and 60.	Age.	51	52	53	54	55	56	57	58	59	60			
	Cases.	3	3	2	5	1	3	4	3	1	3	28	0	28
Between 60 and 70.	Age.	61	62	63	64	65	66	67	68	69	70			
	Cases.	1	2	4	1	1	2	1	1	3	2	18	0	18
Between 70 and 80.	Age.	71	72	73	74	75	76	77	78	79	80			
	Cases.	0	0	0	0	1	0	0	0	1	0	2	0	2
											General Totals	348	7	355

The following table, of similar import, though less extensive and perfect, is taken from the same excellent paper. The district is that of which the town of Leeds forms the centre, and the data are taken from the surgeons' books of the Leeds Infirmary:

* No operation.

	Cases.
10 years and under - -	83
Between 10 and 20 - -	21
20 and 30 - -	21
30 and 40 - -	12
40 and 50 - -	28
50 and 60 - -	21
60 and 70 - -	9
70 and 80 - -	2
	197

197 — Consisting of Males 188, Females 9.

During a period of forty-four years, namely, from 1772 to 1816, according to Dr. Marcet, the following is a summary of the returns of cases of lithotomy in the Norfolk and Norwich hospital:

	Consisting of		
	Males.	Females.	Total.
Children under 14 years	227	8	235
Adults.	251	20	271
Totals	478	28	506

The following table presents a general view of these data; and, as far as they can be exhibited, of the proportions of stone cases before and after puberty, and of their occurrence in the different sexes:

	Bristol.	Leeds.	Norwich.	Total.	Consisting of Males	Females.
14 years and under	178	96*	235	509		
Above 14 years	177	101	271	549		
	355	197	506	1058	1014	44

From these data, therefore, whether taken collectively or individually, it appears, first, that *nearly one half of the whole number of stone cases occurs before the age of puberty*; and from the two first tables, that there is an evident increase in the number of cases about the age of forty years. Secondly, from the general table it appears that the proportion of females to males afflicted with this disease, is only about 1 in 23. The Norwich table appears to show that the proportion of adult females with stone is greater than this estimate, and greater also than that of female children; but the Bristol table is at variance with this conclusion: these are most striking and important facts, the causes of which we shall now proceed briefly to inquire into.

Every one who has paid much attention to the subject, must have remarked, that the urine of children in general before puberty, and more especially from the age of one or two years to seven, is exceedingly liable to every species of deposite. This is, perhaps, common to all children, but it par-

* Estimated partly from the proportions in the Bristol tables.

ticularly occurs in those of a delicate constitution, or whose parents are dyspeptic or subject to gout or gravel. In the earlier stages, I think the kind of deposite is either lithic acid or the lithate of ammonia; but from the irritability of the habit at this period of life, the diathesis is very apt to change to the phosphatic: hence, perhaps, generally speaking, the phosphates are more frequently found to be deposited by the urine of children, than by that of adults. Children on these occasions, if closely attended to, frequently manifest signs of some uneasiness about the back, and are very apt *to wet the bed during the night;* a circumstance almost constantly indicating an unnatural state of the urine, and very frequently gravel. Under these circumstances a nucleus is liable to be formed, the escape of which from the bladder, on account of the small size of the urethra at this age, particularly in boys, is almost impossible. Thus the calculus increases rapidly in size; and, by the irritation it produces, generally brings on the phosphatic diathesis, if it did not exist before, when extraction is the only alternative.

Such is the most usual history of calculi in children; but the case is sometimes very different. Thus, for example, the lithic acid diathesis does not change to the phosphatic before puberty; and, from the diminished chance of its undergoing this transition afterwards, continues present for a

very long time, sometimes till late in life; during the whole of which time the calculus receives occasional additions to its bulk, or perhaps almost constantly goes on increasing. In such cases the constitution is commonly sound, the general health good, and the symptoms by no means urgent—perhaps so slight as to almost escape the notice of a youth in high health and spirits. At certain periods, indeed, from violent exercise, &c. irritation may be felt, and the urine may be rendered bloody; but these commonly soon subside; and the boy, the youth, the gay young man in the prime of life, are alike regardless of trifles, and too frequently disdain to complain or yield. This state of things, perhaps, continues till towards the age of forty; the hey-day of life has now past; the individual has perhaps been married for some years, and, from being less active, has become corpulent and gouty; for some time past the irritation in the bladder has been more frequent and urgent, and he observes that his urine is loaded with gravel; he now begins to take the alarm, and to be apprehensive that his complaint may terminate in stone; a surgeon is consulted, who confirms his apprehensions; and here begins the tale of woe; his new disease haunts him perpetually, and soon begins to affect his health and spirits; at length his constitution gives way—an irritable state of the system comes on—the phos-

phatic diathesis is induced, and a cruel operation, or a miserable death, is the only alternative.

The above is not an imaginary picture. I think I have seen it realised in the majority of instances of lithic acid calculi which have come under my observation. It is, however, in many cases, difficult to persuade patients that their complaint is not new, or of more than a few months' or years' duration; but on questioning them a little more closely, enough will commonly be elicited, to satisfy most of the contrary:—they will often confess, for example, that when they were boys at school, they had occasionally observed high coloured or bloody urine after violent exercise, or that, when young men, they had sometimes observed the same symptoms produced during hunting, or other athletic exercises; with a variety of similar circumstances, which it will readily occur to every one to inquire after.

These remarks are applicable to the lithic acid calculus only, and for the most part to those well marked instances of it, which occur in middle aged individuals. About the time of life when gout usually attacks the constitution, or perhaps a little later, there is commonly a great tendency in the urine to deposit gravel, more especially if this had previously taken place in early life, or the person inherited the complaint from his ancestors: this, therefore, is a most important period for

those subject to such affections, and ought by no means to be neglected; as a calculus already existing in the bladder will very rapidly increase at this period; or if there be none in the bladder already, there is a great risk that a nucleus will be formed in the kidney. A large proportion of calculi occurring in old men seem to be generated about this period.

With respect to the periods of life most subject to the mulberry calculus, I can give very little information. Analogy would seem to show, that it follows nearly the same laws as the lithic acid calculus; though I have some reasons for believing, that it is more apt to occur in the prime of life than that species. The circumstance, also, of the roughness of its surface, constitutes a striking difference between this species of calculus and the lithic; and how much soever the two diatheses may resemble each other in other respects, this circumstance must, I think, cause a striking difference in the mechanical symptoms produced by the two species of calculi, and render it impossible for a mulberry calculus to exist long in the bladder without producing great irritation. With respect to the cystic oxide calculus, still less is known; but the evidence formerly adduced seems to show, that it obeys the general law, in being, most generally formed before the age of puberty.

The phosphatic diathesis seems to occur most

naturally and frequently before puberty and in advanced age; at least when calculi are the exciting cause. But from what has been formerly advanced, it will appear, that this diathesis may be induced at all ages, from the agency of any of those causes calculated to excite it. Hence, it not unfrequently occurs, as an original disease, in young men in the prime of life, without being preceded by the lithic acid, or any other diathesis.

As to the second point, so clearly established by the above data, namely, the infinitely greater frequency of calculous diseases in the male than the female sex, as well before as after puberty; this can be only referred, at present, to the differences existing between the length, &c. of the urethra in the two sexes, the shortness of the female urethra being favourable to the escape of the calculous nuclei. Something, also, may be ascribed, at least in the adult state, to the more regular and sober habits of females.

I should in this place make some remarks on the frequency of calculi in different countries, and in different districts of our own country; also on the comparative frequency of the disease in modern and ancient times; but the data on these points are, in general, too imperfect, at present, to permit us to arrive at any satisfactory results. For what is known on these subjects, we are chiefly indebted to Dr. Marcet and Mr. Smith, to whom,

therefore, I refer the reader. It may, however, be observed, that warm climates in general, and even particular districts of our country, as Hereford (in the hospital of which county there has not been a single applicant for stone since its erection in 1775), appear to be remarkably exempted from these affections. On the contrary, other districts, as that surrounding Norwich, are exceedingly liable to these affections. Mr. Hutchison has shewn that the disease is of rare occurrence among sea faring people.* With respect to the comparative frequency of the disease in ancient and modern times, the most perfect data seem to prove, that the disease is more rare at present than formerly. These facts are very important, but at present they do not admit of a satisfactory explanation.

After these observations, which I trust will be considered as a sufficient illustration of our data, we come to make a few remarks upon a very important question, connected with calculous affections, which medical men are frequently called on to decide; namely, whether the operation of extraction be immediately necessary, or whether it can with propriety be deferred for some time, or even altogether. The observations advanced on the different diatheses, in the former part of this

* Med. Chirurg. Trans. ix. 443.

volume, will enable us to speak with greater certainty on these points than could be done previously; but before we proceed, perhaps, it will not be amiss to inquire briefly into the mortality attending the operation of lithotomy.

The following is a summary of the most perfect data we possess on this subject. The first and most complete table is taken from Mr. Smith's paper, so often quoted, and represents the mortality from lithotomy, as it has occurred at different ages in the Bristol Infirmary:

Age.	Rate of Mortality.
10 years of age & under	1 in $4\frac{1}{2}$
Between. . . . 10 & 20	1 . . 5
. . . . .20 . . 30	1 . . 7
. . . . .30 . . 40	1 . . 5
. . . . .40 . . 50	1 . . $3\frac{1}{3}$
. . . . .50 . . 60	1 . . $4\frac{2}{3}$
. . . . .60 . . 70	1 . . $2\frac{1}{2}$
. . . . .70 . . 80	1 . . 2
Mean at all ages . .	1 in $4\frac{1}{4}$ or { Before puberty,* nearly as 1 in $4\frac{3}{4}$; After do.* nearly as . . . 1 in $4\frac{3}{14}$ }

* Partly estimated

The following table is also taken from the same paper, and refers to the Leeds district. There occurred in the Leeds Hospital,

	Cases of Lithotomy.	Died.	Rate of Mortality.
from 1767 to 1777	.. 24 of which	2	or 1 in 12
.... 1777 .. 1787	.. 62	8	.. 1 ... $7\frac{3}{4}$
.... 1787 .. 1797	.. 23	3	.. 1 ... $7\frac{2}{3}$
.... 1797 .. 1807	.. 42	7	.. 1 ... 6
.... 1807 .. 1817	.. 46	8	.. 1 ... $5\frac{3}{4}$
	Mean at all ages		.. 1 in $7\frac{4}{5}$

According to Dr. Marcet, the mortality in the Norwich Hospital, for the last 40 years, has been

Before puberty, as .... 1 in 18
After puberty .... 1 .. $4\frac{3}{4}$

Or at all ages .... 1 in $11\frac{3}{8}$

From these data it appears, that the mortality from lithotomy has been much less in the Norfolk Infirmary than in either of the others, particularly in the Bristol Infirmary. It also appears, from the Norfolk table, that the risk is less in children than in adults, in the proportion of about four to one; but, on the other hand, from the Bristol table, the chances seem nearly equal. These differences are at present inexplicable; but, I think, from the greater number of cases occurring in the Norfolk Hospital, and other circumstances, that the data

furnished by that Hospital present the most accurate estimate of the relative mortality, before and after puberty, from the operation of lithotomy. If we take the mean of all these data, we shall probably approach very nearly the ratio of mortality, as it occurs from lithotomy, at all ages, over the whole kingdom :

Mean at all ages, in the Bristol Infirmary ..	1	in	$4\frac{1}{4}$
Do. in the Leeds......	1	..	$7\frac{4}{5}$
Do. in the Norwich....	1	..	$11\frac{3}{8}$
Mean ratio of mortality	1	in	$7\frac{3}{4}$, very nearly.

We come now, in the last place, to make a few remarks upon the circumstances which ought to be taken into account, in determining our opinion with respect to the propriety or necessity of the operation of lithotomy.

1. The operation of lithotomy should in general be performed either immediately or as soon as possible, *a.* in all cases of calculus occurring before puberty, of whatever species they may be ; and, *b.* whenever the phosphatic diathesis is distinctly ascertained to be present, or even when the urine abounds with pale coloured lithate of ammonia.

a. Whenever a calculus, no matter of what species, is ascertained to exist in the bladder before puberty, there can, I think, in general, be but one

opnion respecting the propriety of removing it. The reasons are so obvious, that they scarcely need be stated; it will be sufficient to remark, that a long series of inevitable suffering will be thus prevented, the risk of a fatal result diminished, and the chance of a perfect cure rendered greater than in a more advanced period of life. In general it will be better that the operation should be performed immediately; but if the lithic diathesis be steadily present, if the state of the general health be good, and if the sufferings in consequence be moderate, the operation may be delayed till towards the age of puberty, as, from the favourable changes which commonly take place at this period, there will be less risk of the disease returning: but, if the general health appears to have given way, and the patient suffers a great deal of pain and irritation, as is most frequently the case, delays will be exceedingly dangerous. *b.* As to the second point, I give it as my decided opinion that in all cases where the phosphatic diathesis is fairly established, the operation is the only alternative, and the sooner the better. This opinion is founded on the facts sufficiently, I presume, established by the data brought forward in a preceding part of this volume, from which it appears that this diathesis uniformly *succeeds* to all the others; that it never changes when a calculus exists in the bladder, so as to leave room to hope for a better;

consequently that it is the last and worst stage of the disease, and will certainly sooner or later terminate the wretched existence of the patient, if permitted to proceed. The only alternative in such cases, then, is, evidently, to remove the calculus as speedily as possible, before the constitution becomes too deeply affected, and particularly before the bladder becomes diseased, which is one of the most certain and distressing consequences of this species of calculus. Nearly the same remarks apply when the urine is loaded with pale coloured lithate of ammonia, or the disease appears to be in a transition state; as, in this case, I doubt very much, from what I have seen, if the lithic diathesis can ever be fairly re-established, at least while a calculus exists in the bladder.

2. The operation of lithotomy may be frequently postponed under the following circumstances; namely, when the calculus is small or of moderate size, and of the lithic acid species, and when the lithic acid diathesis is steadily present, and particularly if the patient be in the prime of life, the constitution, &c. sound, and the sufferings comparatively moderate; provided always that the patient will conform to the necessary plan of regimen, &c. calculated to remove or diminish the diathesis, and thus to prevent the increase of the calculus.

It has been stated in a preceding chapter, that

a lithic acid calculus has been frequently known to exist in the bladder for a very long time, without producing much uneasiness; it is evident also, that if the urine can be preserved in a perfectly natural state, a calculus thus situated can receive no increase in bulk; but it has been rendered probable, that these two circumstances co-exist; namely, that a perfectly natural condition of the urine is generally accompanied by freedom from pain and irritation, in this, as well as in all other species of calculus: under these circumstances, therefore, I should feel great hesitation in recommending a person in the prime of life, with perhaps a family of children depending upon his exertions, to risk his life by submitting to the operation of lithotomy; at least, till it had been ascertained, that the means proper for rendering the urine natural, &c. had been resorted to, and had failed; or if they had been found temporarily beneficial, that they could not be persevered in. But if the proper means have been resorted to at an early period of the affection, which is of the first importance; and if they prove adequate to restore the natural condition of the urine, and thus prevent the increase of the calculus; and if patients will conform to the necessary regimen, &c. with the view of preserving matters in this state, I am fully satisfied, from what I have seen, that in by far the greater number of instances, the subjects

of this disease may pass a great many years, perhaps a whole life, with a small or moderately sized lithic calculus in the bladder, with comparatively very little suffering; and that thus the necessity of a cruel and dangerous operation may at least be put off till a period when life may be of less consequence, or perhaps altogether. On the contrary, if a patient be not sufficiently a stoic to adhere to the restrictive regimen, and other necessary means; or if these do not give him ease, or restore the natural condition of the urine; or if his situation in life or daily occupation expose him to violent exercise, or other unfavourable circumstances; I wish it to be distinctly understood, that in such cases the above advice *is inapplicable, and the retention of the calculus dangerous.*

How far the above rules are applicable to the mulberry and cystic oxide calculi, I do not know. The rough surface of the mulberry calculus will probably produce, in most instances, too much irritation to be retained in the bladder for any length of time; but, with the exception of this circumstance, I have the strongest reasons for believing, that this calculus is subject to nearly the same laws as the lithic acid species. Of the cystic oxide calculus, for the reasons already so frequently repeated, I can say nothing.

In conclusion, it may be observed, that I wish

the above remarks to be understood in a general sense, and as totally independent of surgical reasons or difficulties, with which I have nothing to do; but which must likewise be obviously taken into account, in all cases of calculus in the bladder.

With respect to the operation of *solvents* of the stone, which formerly so much occupied the attention of the profession, I know nothing, and hence have avoided the subject altogether. From what little I have seen, I am very much disposed to doubt if they can ever be so administered as to produce the desired effect; and this I believe is the general opinion on the subject.

THE following is an attempt to illustrate the observations respecting the tints exhibited by the different sediments, composed chiefly of the lithic acid and lithate of ammonia. See page 121, et seq.

I have recently met with sediments so strikingly illustrative of the opinions formerly advanced, and so characteristic of the first and second classes, that I have been induced to change the names before given, simply to *yellow* and *red* sediments. The colour of the sediment I had before adopted as characteristic of the first class, and which was the most perfect I had then seen, was identical with that of *ripe nuts ;* hence the name. But this sediment evidently contained *red*, and therefore belonged to the second class, of which it constituted a pale variety.

I. *Yellow Sediments.*

These owe their colour almost entirely to the natural colouring principle existing in healthy urine. No. 1 and 2 are the tints sometimes exhibited by crystallized gravel, when tinged simply by the principle in question. The paler tints of this class, as No. 3, are sometimes met with during the transition stage existing between the lithic acid and phosphatic diatheses. This class of sediments is confined to peculiar states of the general health, and does not necessarily indicate fever.

II. *Red or Lateritious Sediments.*

No. 1 is the most perfect tint of this class, and is not common, being confined for the most part to crystallized gravel deposited during fever or inflammation. No. 2 is the tint, some shade of which is usually assumed by amorphous sediments deposited during fever. No. 3, or some tint between this and No. 3 of *yellow* sediments, is perhaps the most frequent of all the forms assumed by amorphous sediments, and is that which occurs during slight feverish irritability produced by errors in diet, &c. This class of sediments almost always indicates more or less of fever, and owes their colour to a mixture of the tints of the first and third classes.

III. *Pink Sediments.*

This class of sediments owes their colour to the purpurate of ammonia chiefly, and is rather of uncommon occurrence. No. 1 is taken from a very perfect specimen sent me by Mr. Astley Cooper. It occurred after the operation of paracentesis, for dropsy. Nos. 2 and 3 are also from dropsical urine. Mr. Cruickshank supposed this form of sediment to indicate disorganization of the liver. I am disposed to agree with him so far, as to believe that it frequently indicates some great derangement, if not disorganization, of that viscus.

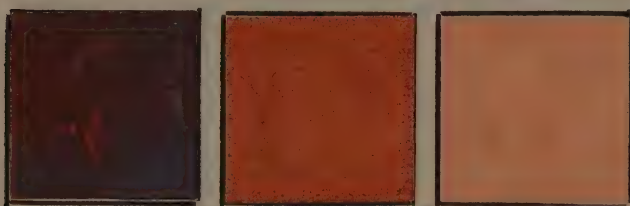
I. *Yellow Sediments.*

No. 1. No. 2. No. 3.



II. *Red or Lateritious Sediments.*

No. 1. No. 2. No. 3.



III. *Pink Sediments.*

No. 1. No. 2. No. 3.



It may be observed that the above are intended to represent the *general* characters only of the colours in question. Every one must have observed that these sediments occur of all possible shades; hence, the different classes gradually run into one another, so that it is difficult to say, in some instances, to which a specimen belongs.

THE END.

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